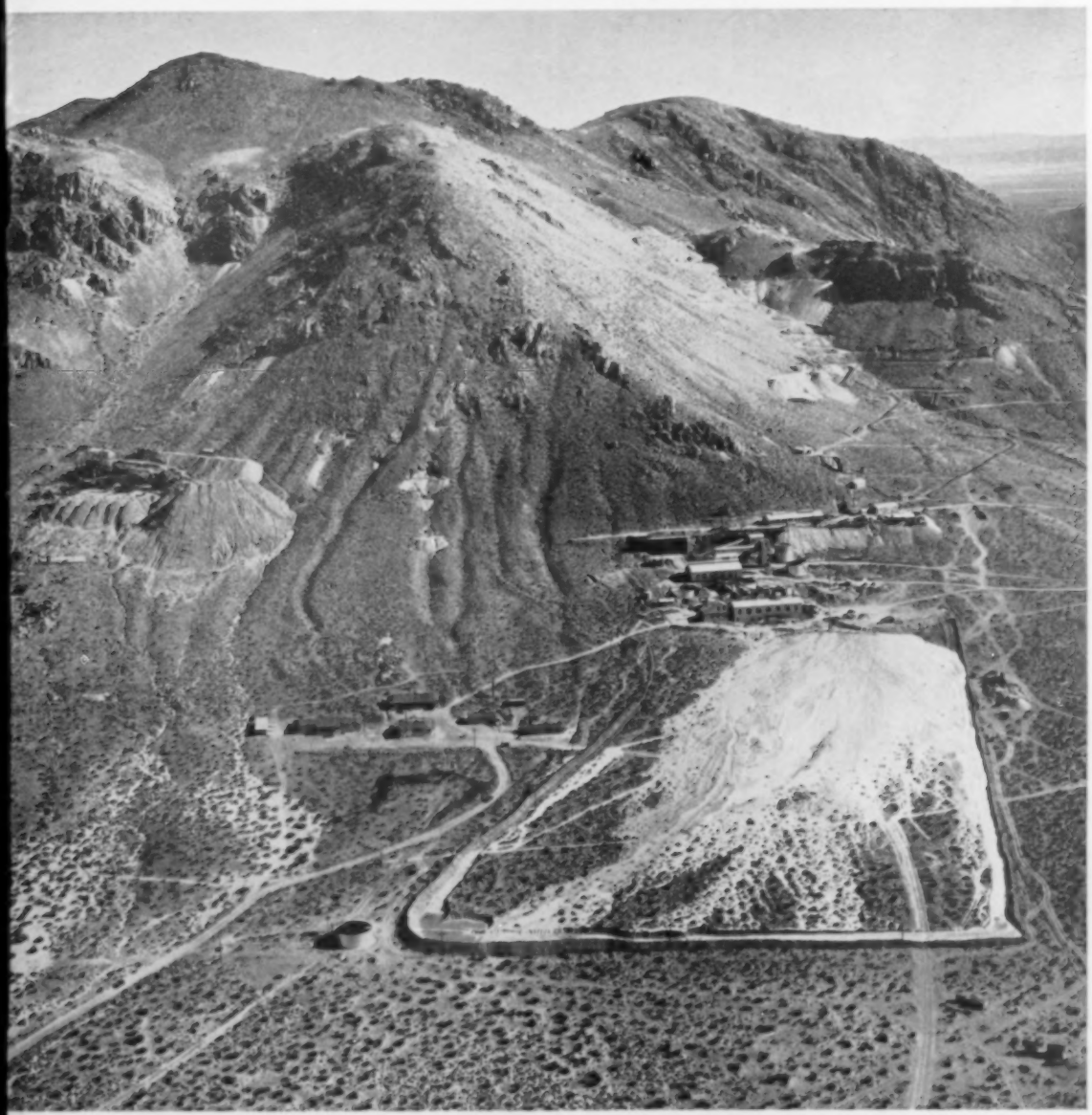
Compressed Air Magazine

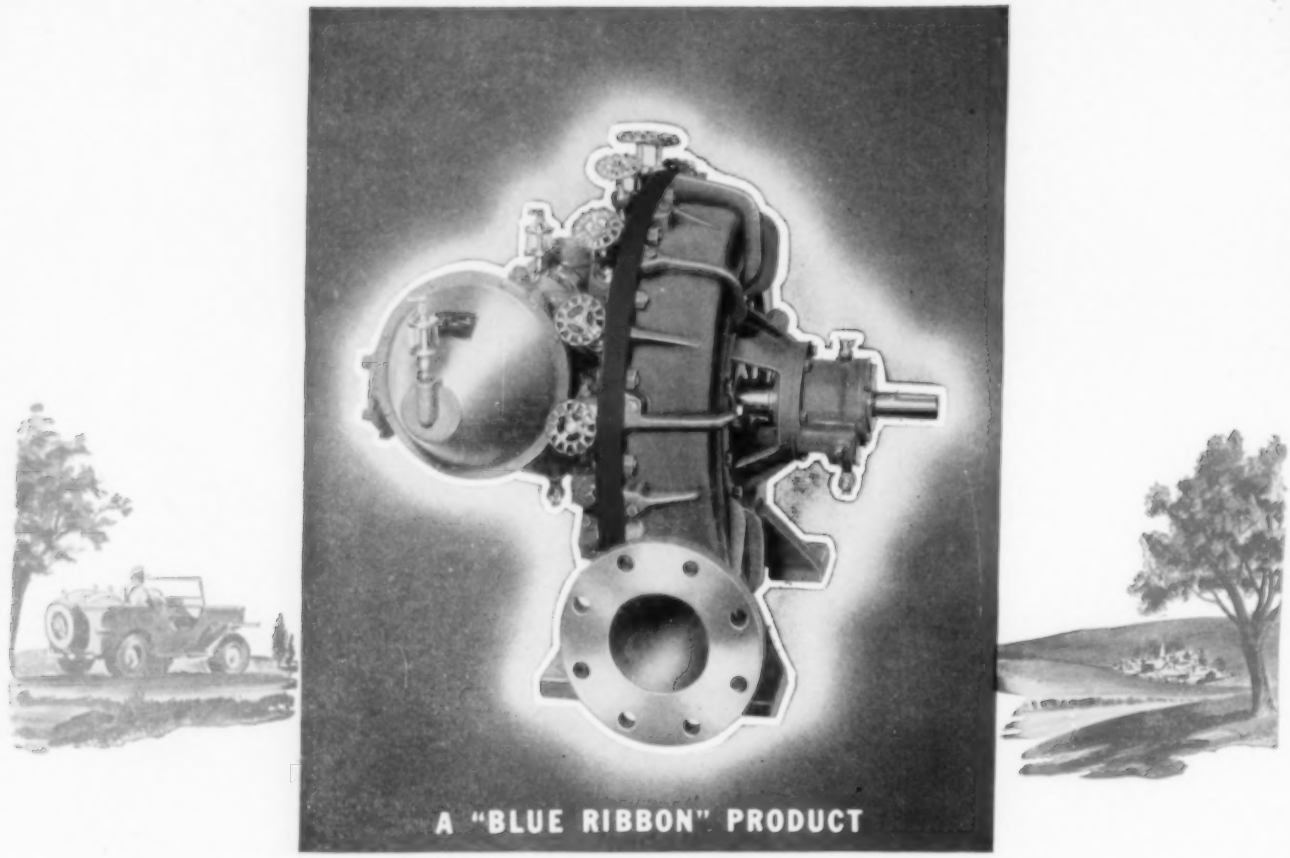
OCTOBER 1945



GOLD MINE ON MOJAVE DESERT

Closed by a wartime edict properties such as this one may reopen soon

VOLUME 50 • NUMBER 10 NEW YORK • LONDON



THEY CALL 'EM JEEPS

BECAUSE THEY'RE SMALL, BUT POWERFUL, AND GO ANYWHERE

For a small, tough, hard-working turbine that will go anywhere and do all you expect of it . . . get a Coppus "Blue Ribbon" Steam Turbine.

Coppus Steam Turbines come in six frame sizes from 150 HP down to fractional—so you can match more closely your job requirements. Each smaller size is priced correspondingly less, so by selecting "horsepower" instead of "elephant power" you save on investment and installation cost.

Many well-known manufacturers install Coppus "Blue Ribbon" Steam Turbines on original equipment. They know Coppus quality will protect the reputation of their own products. The Coppus Turbine is also being used on many U. S. Destroyer Escorts, all Casablanca class aircraft carriers and 90% of all Landing Ship Docks.

Like all Coppus "Blue Ribbon" products (blowers, ventilators, gas burners, etc.), the Coppus Steam Turbine is a precision-made product, with accuracy controlled by Johansson size blocks. Every turbine is dynamometer-tested before shipment.

More than 85% of all orders since 1937 have been repeat orders.

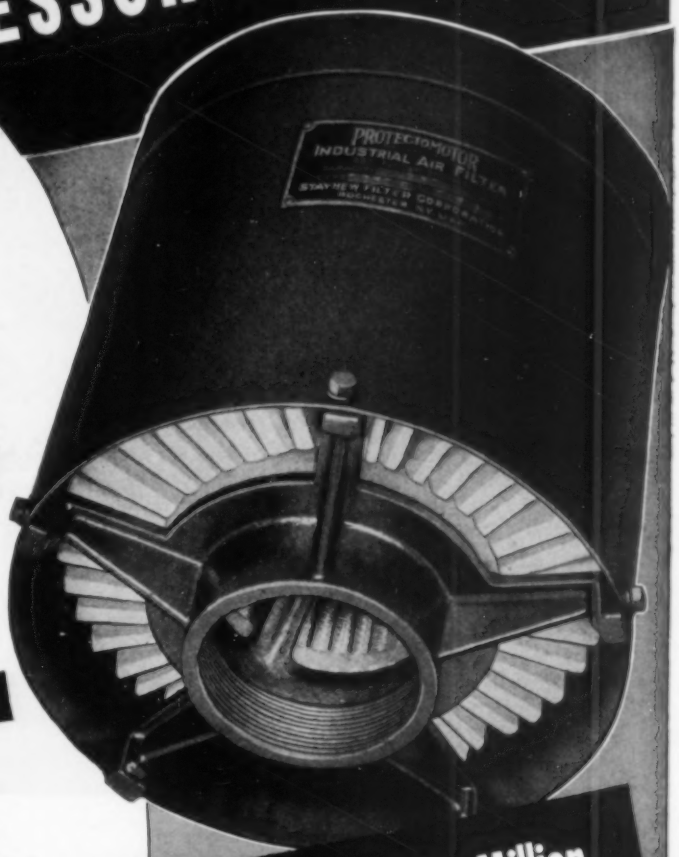
Write for Bulletin 135-9. Coppus Engineering Corporation, 210 Park Avenue, Worcester 2, Mass. Sales offices in THOMAS' REGISTER. Other Coppus "Blue Ribbon" Products in SWEET'S, CHEMICAL ENGINEERING CATALOG, REFINERY CATALOG.

ANOTHER

COPPUS

"BLUE RIBBON" PRODUCT

WHY PROTECTOMOTOR INTAKE FILTERS ARE BEST FOR AIR COMPRESSOR USE



★ HIGH EFFICIENCY WHEN INSTALLED

Protectomotor Air Filters for internal combustion engines and compressors feature dry-type filtering media. These media are selected to fit particular installation conditions. They have been scientifically tested in the laboratory and proven by field use. Used in combination with the patented Radial Fin Insert Construction, they provide highest operating efficiency.

★ INCREASED EFFICIENCY WITH USE

Protectomotor filtering efficiency actually *increases* when dust begins to accumulate on the surface of the media, since this forms a precoating or filter-aid of the very material which is being handled.

★ LOW RESTRICTION TO AIR FLOW

Protectomotors at maximum ratings offer initial resistance to air flow of less than ½" of water. Since the exclusive Radial Fin Construction provides a maximum of filtering area, this resistance is held to a minimum throughout the life of the filter.

★ SERVICING SELDOM NECESSARY

The Protectomotor is a masterpiece of simple, rugged construction. There are no moving parts, no reservoirs, no liquids. The extremely large active filtering area reduces cleaning to an absolute minimum for any given set of conditions. When required, cleaning is quickly and easily accomplished by vacuum, compressed air, or washing.

★ POSITIVE PROTECTION ★★★

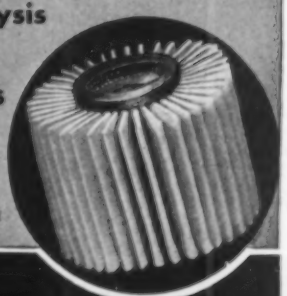
Inherent characteristics of the dry-type filtering media provide *positive* protection. Performance is *not* dependent upon periodic renewal of viscous coatings or other filter aids. Ideal for dust storm areas.

★ EFFICIENT AT HIGH OR LOW TEMPERATURES

As the filtering media used are of the dry-type, peak efficiency is maintained under all atmospheric conditions. There is no oil to evaporate at high temperatures or to congeal at low temperatures.

More than Half a Million Installations on Internal Combustion Engines and Compressors since 1920

Write for Catalog and Data Blank for Free Analysis of your Requirements



Radial Fin Construction

STAYNEW PROTECTOMOTOR FILTERS

DOLLINGER CORPORATION
(Formerly Staynew Filter Corp.)
7 Centre Pk., Rochester 3, N. Y.

HIGHER PRODUCTION ASSURED

with

AIR TOOLS

Naturally production increases when hand-held portable tools can be used. Even higher production is assured when the tools are air-operated. This is because **AIR TOOLS** are able to start and stop instantly.

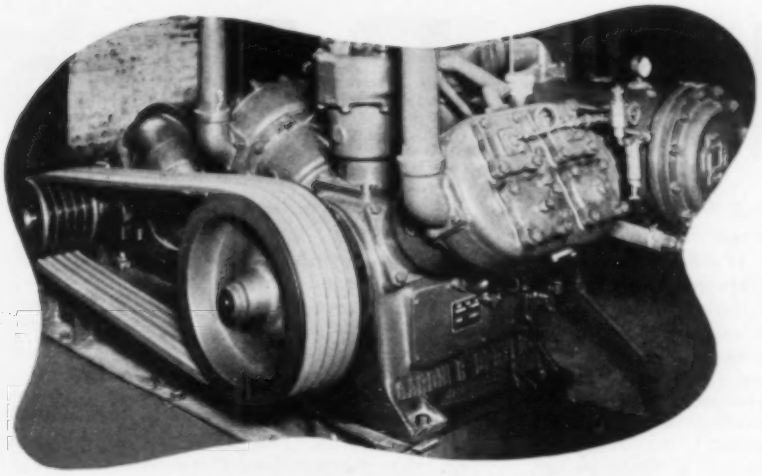
This positive response to operator control is but *one* of their *many* advantages, but it means—that full power is available immediately—that there is no overspin when the tool is shut off—that spotting the next operation is quickly and easily done—that air tools are safer. Briefly it means that production, and especially repetitive operations, can be greatly speeded up with Air Tools.

Ingersoll-Rand

11 BROADWAY, NEW YORK 4, N. Y.

8-574

COMPRESSORS • TURBO BLOWERS • ROCK DRILLS • AIR TOOLS • OIL AND GAS ENGINES • CONDENSERS • CENTRIFUGAL PUMPS



THOUSANDS KEEP COMPRESSOR

VALVES CLEAN

By using lubricants that do not form gum or hard carbon deposits

TEXACO Alcaid, Algol or Ursa Oils assure you lively valve action—plus longer service between overhauls, fewer repairs and replacements, better performance at lower cost.

Texaco Alcaid, Algol and Ursa Oils—typical examples of petroleum products improved through The Texas Company's constant research—assure wide-opening, tight-shutting valves, free rings, open ports and clear air lines. They are made in one of the world's largest refineries from carefully selected crudes processed by modern Texaco methods to provide efficient and economical compressor operation. Their production is 100% Texaco controlled from well to finished product to assure absolute uniformity.

Because of their outstanding qualities, *Texaco Alcaid, Algol and Ursa Oils* are used by thousands of air compressor operators all over the world.

Texaco Lubrication Engineering Service is available through more than 2300 Texaco distributing plants in the 48 States. Get in touch with the nearest one, or write The Texas Company, 135 E. 42nd St., New York 17, N. Y.

TEXACO

TEXACO Lubricants

FOR ALL AIR COMPRESSORS AND TOOLS

TUNE IN THE TEXACO STAR THEATRE WITH JAMES MELTON EVERY SUNDAY NIGHT—CBS

Flood-Proof

When water spurted from the face of the Leadville Drainage Tunnel being driven a distance of 17,556 feet, it was not a pleasant little sprinkle or even a sizable stream, but rather a veritable river flood—as much as 6000 gallons a minute flowed from the unbroken rock ahead—a real hazard, but not for far-sighted contractors who anticipated these conditions and provided the type of equipment that couldn't be stopped. The Eimco RockerShovel is flood-proof. Though thousands of gallons of water per minute washed away every particle of lubrication on exposed surfaces, the efficiency of the RockerShovel was unimpaired. Designed by men who know underground conditions, the RockerShovel can deliver at its maximum efficiency handling dry or wet muck. All gear trains are completely sealed in cast steel gear cases and run in a bath of oil — no moisture can get in and no oil can get out.

The sealed gear case is only one of the many advantages of the Rocker-Shovel. Powerful Ingersoll-Rand air motors insure maximum crowding and digging force. The patented rocker-arm of the RockerShovel provides lowest headroom requirements for any given car. The RockerShovel is easier to operate and lower on maintenance costs—all these statements, and many more, are proven facts.

Write for more loader information.

RockerShovels

Eimco Rocker Shovel

The pictures shown on these pages were taken in the Leadville Drainage Tunnel, Leadville, Colorado. Draining water from this valuable mining district will allow three to four million tons of lead, zinc and manganese ores to be mined economically. The elevation at the portal of the tunnel is 9957 ft. and the total proposed length when completed will be 17,556 ft.

The water flow at the time the pictures were taken was about about 3000 gallons per minute. The maximum flow in this vicinity was 7000 gallons per minute, of which 6000 gallons a minute were issuing from the face.

EIMCO

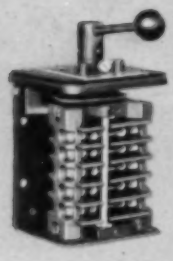
THE EIMCO CORPORATION

A-101

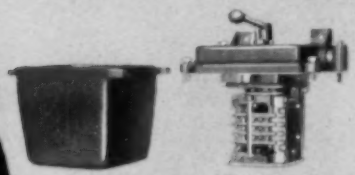
Executive Offices and Factories: Salt Lake City 8, Utah
Branches: New York, Chicago, El Paso, Sacramento, St. Louis

MOTOR STARTERS

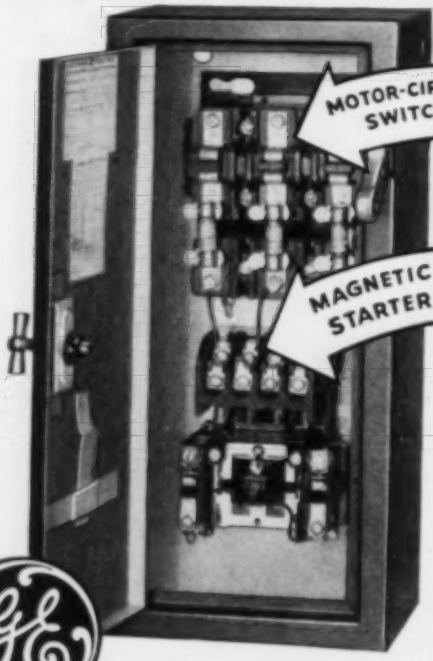
FOR EVERY MACHINE APPLICATION



Small size—general purpose. Our small-size switch is cam-operated and spring-return to the off position. This particular device is recommended for single-speed reversing service or for two-speed non-reversing service.



Small size—dust-tight and watertight. The small size, too, comes in a variety of enclosures to meet different operating conditions. An example is this three-pole, reversing, rotating-cam switch in a watertight and dust-tight cast-iron case. It provides one point forward and one point reverse.

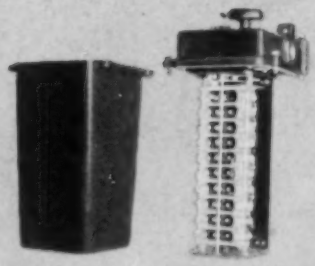


WHY BUY TWO DEVICES WHEN ONE WILL DO THE JOB?

This G-E COMBINATION STARTER gives you in a single package both a motor-circuit switch and a magnetic starter

★ DEPENDABLE ★ ATTRACTIVE IN APPEARANCE ★ DESIGNED TO BLEND WITH MODERN MACHINES

For full-voltage starting of squirrel-cage a-c motors



Multispeed—dust-tight and watertight. Rotating-cam switches come in enclosures to meet your needs. Here is a reversing, multispeed, rotating-cam switch in a watertight and dust-tight cast-iron case. This switch provides four speeds forward and one speed reverse.

INDUSTRIAL CONTROL

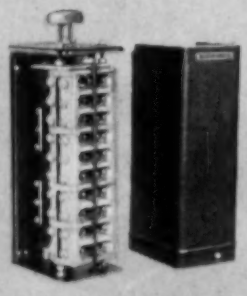
When you need motor starters, be sure to investigate G-E's complete line—perhaps some may give you important savings in time, space, or materials.

Take combination starters, for example—because you buy one packaged unit, less time is required for ordering and for installation. You can save space, too, by mounting them in small, unused places either near to or remote from the operator. And critical materials are conserved because these starters have less copper wire, steel conduit, and fittings than separately mounted devices.

Also shown here are other G-E starters—leaders in their field. They range from a general-purpose type of rotating cam switch to a full-voltage, multispeed magnetic starter. Frequent starting, remote control, different starting speeds, and many other special requirements can be obtained by selecting one of these starters.

And all G-E starters come in a variety of enclosures designed to meet different operating conditions.

We'd like to send you any additional information you may want. And, remember, our engineers will be glad to assist you in selecting exactly the right starter for your needs. Get in touch with your local G-E office today. Or if you prefer, write directly to General Electric Company, Schenectady 5, N. Y.



Multispeed—general purpose. This general-purpose type of rotating-cam switch is available for single-, two-, three-, or four-speed motors requiring either forward and/or reversing service. Particular care has been taken to insure you of obtaining the long-lived service that you want in a switch.

Buy all the BONDS you can—*and keep all you buy*

GENERAL ELECTRIC

676-127C-6010

TIER-LIFT 4,000 to 10,000 LBS.

The original Tier-Lift, brought out by Lakewood Engineering Co., is the huskiest of all types of high lift trucks. It has a greater lifting capacity in proportion to its dead weight than any other model. It fills an extensive field where loads require high elevation for transfer to storage and where ease and safety of operation are important factors.

Easton took over Lakewood Engineering Company's truck division in 1931 and since then has carried on the further development of this unique and efficient material handling unit.

Write today: Engineering Counsel, Easton Car and Construction Company, Easton, Pennsylvania.

THE ORIGINAL TIER-LIFT AS NOW BUILT BY

EASTON

INDUSTRIAL CARS
TRUCK BODIES · TRAILERS
ELECTRIC LIFT TRUCKS

A-1007

Must for the Army...

Best for You!

WAR BONDS
A PIPE LINE FROM YOU TO HIM

The Army Engineering Manual on portable pipelines specifies the VICTAULIC COUPLING as standard . . . and standard for the Army means *best* for you! Africa . . . France . . . Italy . . . Germany . . . the Pacific . . . the toughest proving grounds in the world have demonstrated Victaulic superiority.

HERE'S WHY ARMY ENGINEERS CHOSE VICTAULIC . . .

QUICKLY INSTALLED . . . *often under direct enemy fire*

PERMANENT . . . *will outlast the pipe*

RECLAIMABLE . . . *can be uncoupled and re-used*

FLEXIBLE . . . *follows contours of the ground*

NO MAINTENANCE . . . *upkeep costs nil*

SECTIONAL REPAIR . . . *any section between couplings easily removed and replaced*

VICTAULIC

Reg. U. S. Pat. Off.

SELF-ALIGNING PIPE COUPLINGS AND FULL-FLOW FITTINGS

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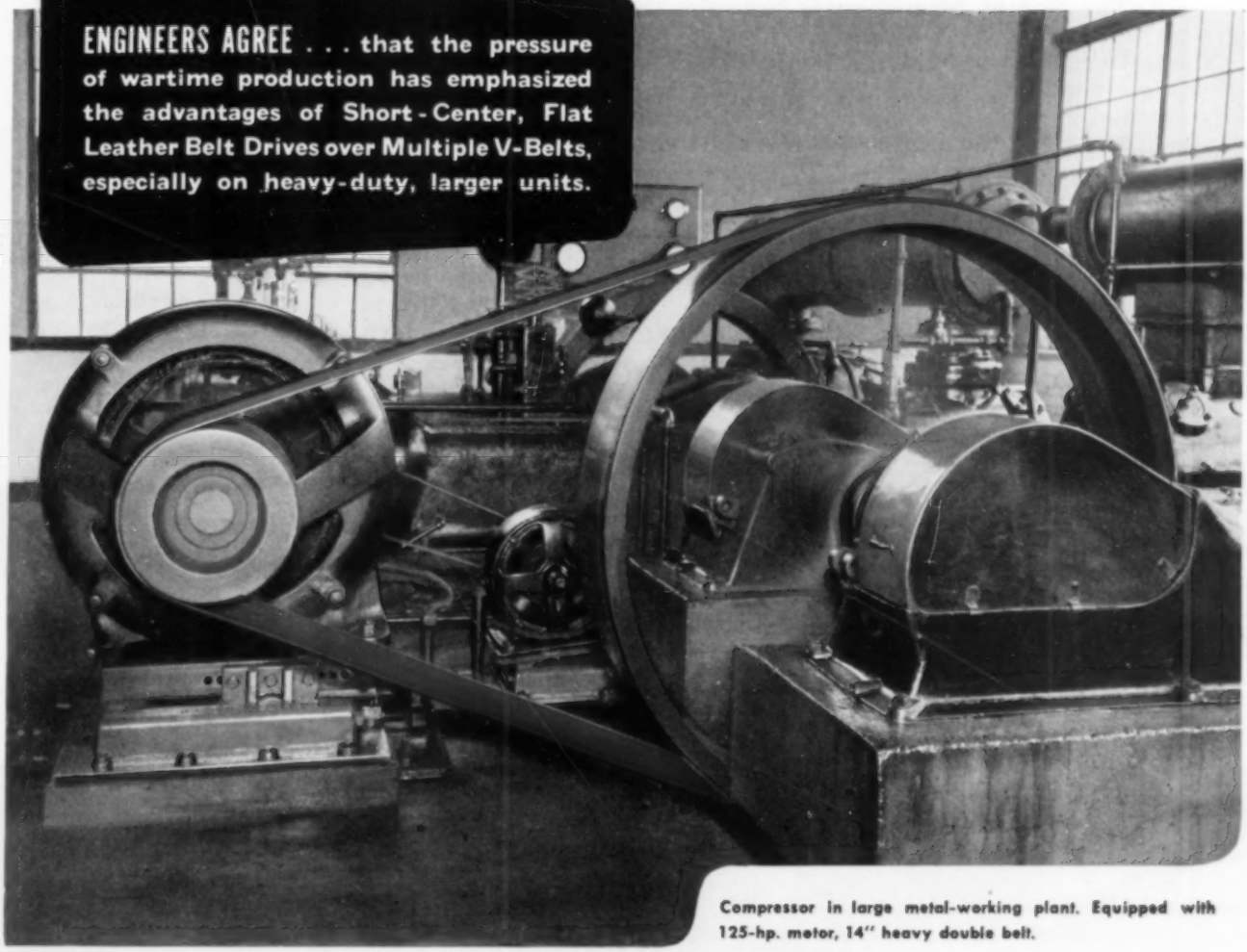
Here, then, is a superior coupling with many features . . . suited for your own industrial applications, on land or marine. Write us for your copy of The New Victaulic Catalog and Engineering Manual and get acquainted with the remarkable coupling that will benefit your own pipeline installations . . . Address VICTAULIC COMPANY OF AMERICA, 30 Rockefeller Plaza, New York 20, N. Y. Other Victaulic offices—Victaulic Inc., 727 W. 7th St., Los Angeles 14, Calif.; Victaulic Co. of Canada, Ltd., 200 Bay St., Toronto.

OIL MINING MARINE MUNICIPAL INDUSTRIAL

Leather Belting

DOES THIS JOB BEST

ENGINEERS AGREE . . . that the pressure of wartime production has emphasized the advantages of Short-Center, Flat Leather Belt Drives over Multiple V-Belts, especially on heavy-duty, larger units.



Compressor in large metal-working plant. Equipped with 125-hp. motor, 14" heavy double belt.

Leave it to Leather to give more reliable power transmission, greater production, and added profit through longer service-life.

For flat leather belting has the highest permanent pulling-power of any known belting material.

Leave it to Leather to absorb overloads, to take punishment which other designs or materials can't withstand.

Leather belting insures *permanent* pulley-grip . . . less loss of compressor capacity.

Leave it to Leather!

AMERICAN LEATHER BELTING ASSOCIATION · 41 Park Row, NEW YORK 7, N. Y.

THE MOTOR PUMP LINE

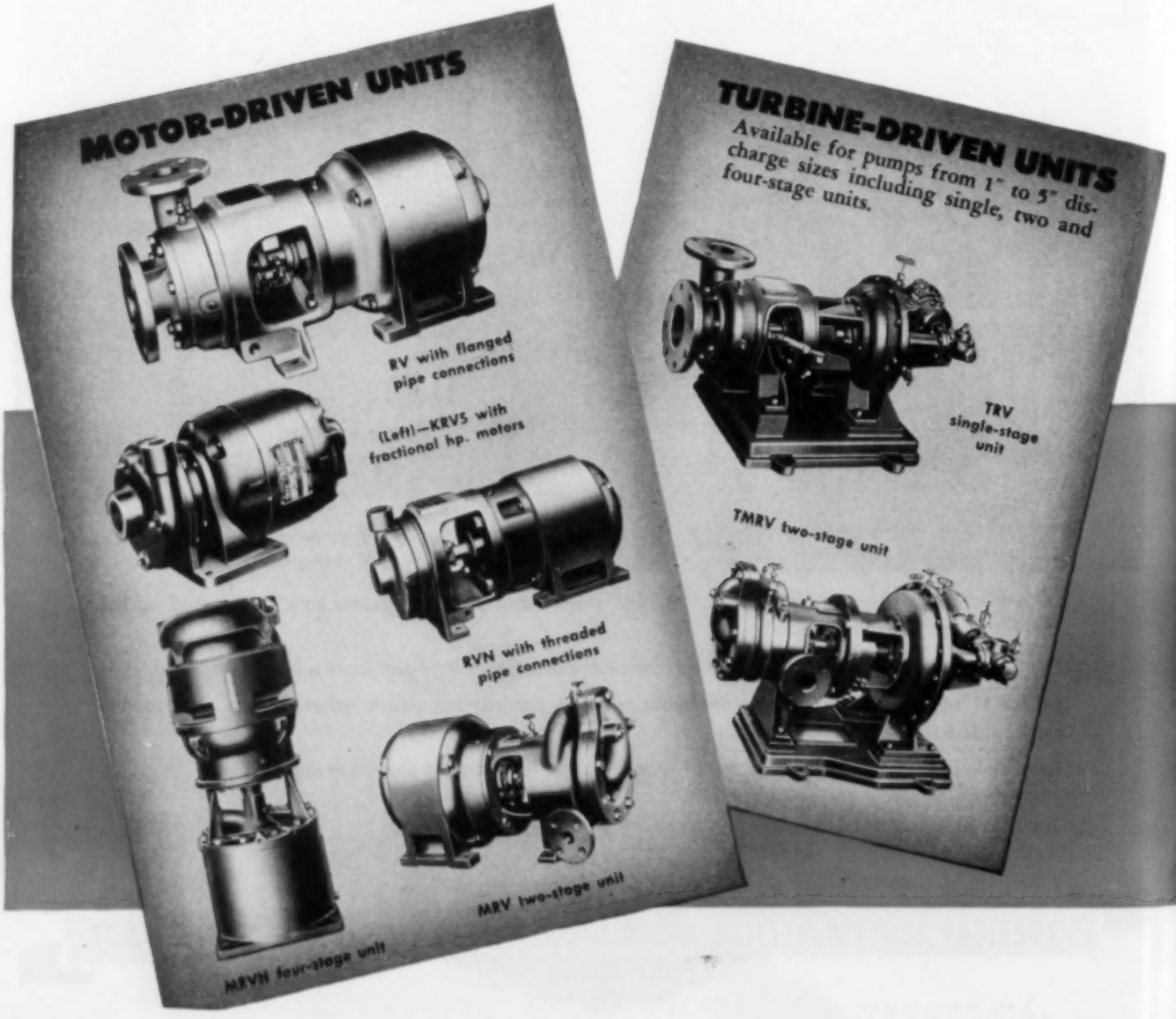
AN INGERSOLL-RAND *Service*

The line of Motorpumps provides the most complete selection of pumping units within its range. (Capacities to 1800 gpm, heads to 600 ft.).

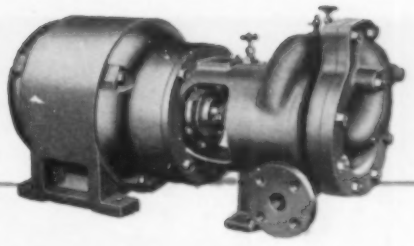
The Motorpump is a compact and efficient centrifugal pump having the impeller and the rotor of the motor on the same shaft. Pump and driver are a single rigid unit.

The same pump casing and parts combined with a turbine produce a similar compact turbine-driven pump.

Pumps are also available on cradles for any type of drive.


MOTOR-DRIVEN UNITS
RV with flanged pipe connections
(Left)—KRVS with fractional hp. motors
RVN with threaded pipe connections
MRV two-stage unit
MRVH four-stage unit
TURBINE-DRIVEN UNITS
Available for pumps from 1" to 5" discharge sizes including single, two and four-stage units.
TRV single-stage unit
TMRV two-stage unit

1/4 To 50 HP.



TO ALL PUMP USERS

Where Motorpumps can be used — Motorpumps can be used wherever liquids must be pumped. Tens of thousands are in use in the petroleum, chemical, and other industries handling not only water, but an almost unlimited variety of other liquids.

Range of Sizes — Single-stage Motorpumps are available in discharge sizes from ¾" to 5" to handle capacities up to 1800 gal per min against heads up to 250 ft (110 lb per sq in). Two-stage and four-stage units handle up to 500 gal per min against heads up to 600 ft (260 lb per sq in). Often it is economical to use several Motorpumps together to obtain still larger capacities.

Modifications extending range of usefulness — Motorpumps are available in three standard material combinations; all iron, bronze fitted and all bronze, to handle a wide variety of liquids. Other modifications include open impellers for paper stock or viscous liquids, grease-sealed stuffing boxes or mechanical seals for petroleum products, hardened shaft sleeves and shrouded wearing rings for abrasive liquids, smothering glands, and water-cooled stuffing boxes for hot liquids, sling-yoke mounting for mine-shaft service.

Economical to use — Motorpumps are built on a production basis in a plant devoted exclusively to the manufacture of pumps. They are, therefore, economical in first cost. Moreover, they are quality units in every respect. Features such as heavy shaft, large ball bearings, sealed shaft sleeves and rigid construction assure long life. Their high efficiency keeps power requirements at a minimum. Their compactness cuts down installation cost and saves floor space which is often at a premium—they can be mounted on a wall or ceiling.

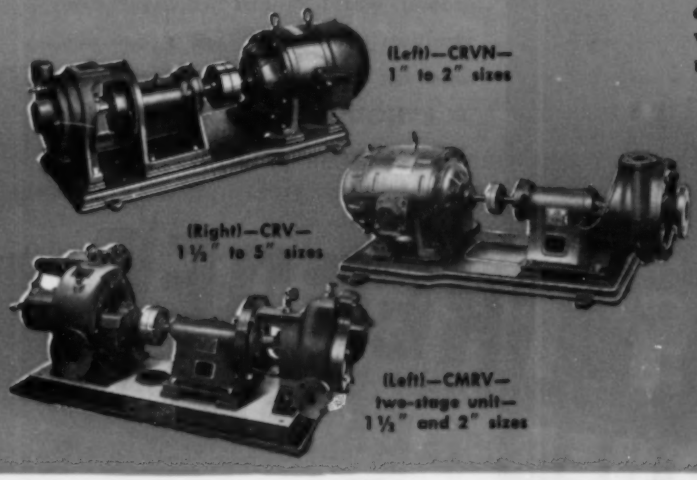
Availability — At one time we could and did say "Wire us for a Motorpump and we will ship it within 24 hours". We hope we can soon return to that basis. In the meantime, we can often give you shipments better than you expect under wartime conditions. Motorpumps are carried in stock by Ingersoll-Rand branch offices and by many dealers. This stock arrangement sometimes enables us to perform miracles even under today's difficulties.

* * * *

The Motorpump Catalog contains full information. Write our nearest branch for your copy—and for any engineering assistance. Ingersoll-Rand Company, 11 Broadway, New York 4, N. Y.

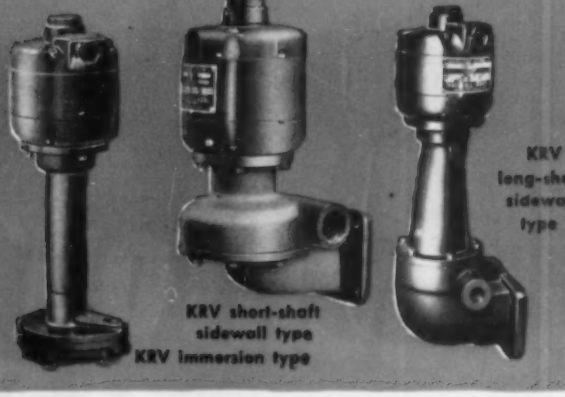
CRADLE-MOUNTED UNITS

for any type of drive



VERTICAL UNITS

For mounting directly on equipment such as machine tools, evaporative condensers, dairy machinery, washing machinery, etc. KRVS and RVN horizontal units are also suitable for such uses.



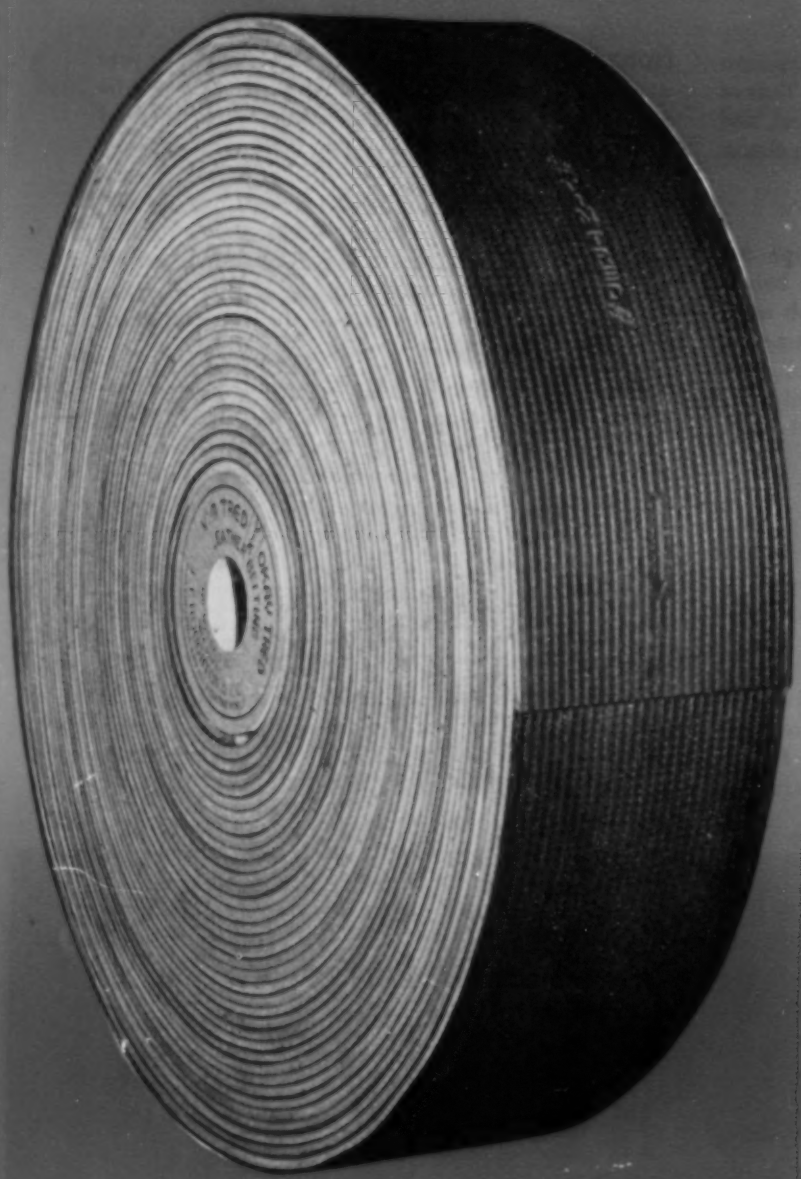
9-639

Ingersoll-Rand

11 BROADWAY, NEW YORK 4, N. Y.

MORE PRODUCTION...

because it's treaded!



We start making leather belting from selected hides . . . tanned in our own tannery by the VIM mineral method that results in leather with high coefficient of friction, strength and flexibility.

Then we give it an additional treatment no other belting house can provide—treading. Placing the belt under pressure, a "non-skid" tread is imprinted on it. Tension is thus concentrated on the raised portion, without increasing total belt tension. The treaded belt grips better, slips less, delivers more power.

So when you put a VIM Tred Leather Belt on your pulleys, you're assured of the maximum of pulling power, which means increased production . . . Write for a sample, and for our helpful belt manual. E. F. HOUGHTON & CO., 303 W. Lehigh Avenue, Philadelphia 33, Pa.

HOUGHTON'S TREADED LEATHER BELTING

Piston Rings · Piston Rings · Piston Rings · Piston
NOW · YOU CAN GET
American
Hammered
IN EVERY SIZE · OF EVERY TYPE · FOR EVERY PURPOSE

You can get all the American Hammered Piston Rings you need, in any size . . . of any type . . . for any purpose . . . just as promptly as you did in pre-war years.

You'll find that these new rings reflect a quarter-century of peacetime skill and experience and *another* quarter-century of experience and progress that was crowded, by the needs of the nation, into five years on the calendar.

Wartime accomplishments include the production or perfection of such revolutionary new developments as the wear-banishing "PORUS-KROME" * treatment, and the life-extending, performance-boosting high-tensile alloys.

Let us demonstrate that now as in the past, American Hammered Piston Rings plus American Hammered engineering service give the answer to every ring need.

KOPPERS COMPANY, INC.

American Hammered Piston Ring Division

Baltimore 3, Maryland

* VAN DER HORST PROCESS

KOPPERS

THE INDUSTRY THAT SERVES ALL INDUSTRY

BULLETIN!

How to Take a Reconversion Inventory of Your Electric Motors

☛ As new manufacturing equipment becomes more widely available, and as you reconvert your production toward a peacetime basis, you may be faced with an unprecedented problem of inventory-taking.

☛ You may have to determine — more quickly than such a job has ever been done before — the exact condition of every piece of existing equipment you propose to use in peacetime production.

☛ For about four years, far greater emphasis has been placed on setting production records than on keeping maintenance records; condition of equipment is often unknown. Because much equipment has been worked during wartime three and four times as many hours a year as in peacetime, calendar age may mean nothing. And repair has often depended on American ingenuity and baling wire.

☛ Here are some of the standards you need to determine which of your electric motors: (1) are okay as is, (2) need repair or new parts, (3) will shortly require replacement, (4) need reapplication.

☛ These standards generally apply to all makes of motors; when in doubt on any motor, consult its manufacturer.

1 START YOUR INVENTORY WITH THE RECORDS

Begin your motor inventory with the history of each motor; you'll save much time and effort . . . you'll be guided quickly to the units which most need attention. Written records and the mental recollection of foremen and maintenance men are the source of this information.

Check the *master maintenance records* (though in most plants this file is out-of-date and incomplete, because of wartime pressure on production); and get *reports from foremen* (in a small plant, it may be possible to interview each man; in a large plant, it may be more efficient to distribute blank forms, such as the "MOTOR CHECK LIST" on opposite page.)

Look into the service to which the motor has been subjected in wartime: has it been overloaded? underloaded? worked 3 shifts daily? allowed to go to work in spray, steam, flood, acids? has it had mechanical injury? has it stood idle, collecting moisture and dirt?

Knowing the answers to these questions will help you spot motors that may soon give you trouble . . . you can start your inventory there.

NOTE: All new motors built during wartime, under WPB limitation orders, contain minimum amounts of critical materials. Thus, unlike many prewar motors, they have been incapable of withstanding continued overload operation in the way you've come to expect high-grade American motors to do. Moreover, you've had to take motors at the ratings you could get, without much regard to the exact requirements of the application. Thus, many motors have been running harder and at higher temperatures than nameplate ratings call for. Obvious result of this combination of factors is shortened insulation life. So—*expect* trouble where wartime motors are misapplied.

2 THEN CHECK MOTORS IN OPERATION

Obviously, the easiest and most practical measure of a motor's present condition is the way it is now operating. You can't learn all you need to know about its probable future performance by observing it in use, but a motor does reveal certain symptoms of trouble while doing its job.

Check the power line voltage and frequency and compare with the voltage and frequency of the motor as stated on the nameplate. To perform properly, a motor must be supplied from a line whose characteristics correspond with those for which the motor was designed.

Check rpm — hand revolution counter makes this easy. Just remove cap, hold counter against end of shaft, and take a timed reading; compare with nameplate rating.

Take temperature readings — not by the "blistered hand" or "touch and yell" system, but *accurately*, with *thermometers*.

Find the temperature of the *motor* by taping or cementing thermometer to the stator iron . . . take the reading, and add 15°C. (The difference between the heat on the outside surface and the possible heat of the hottest part inside).

Compare motor temperature with temperature rise rating on the nameplate. Normally a 40° rise is considered acceptable; top temperature usually should not exceed 80°C.

Take the temperature of *bearings*

either by taping or cementing thermometer to the bearing housing, or by inserting it into the oil well. In general, maximum safe bearing temperature is 96°C. (Bronze bearings may take somewhat higher temperature safely. When in doubt, consult motor manufacturer.)

Listen for — EXCESSIVE HUM. May be caused by uneven air gap, and may call for replacement of bearings. Or it may be caused by loose laminations or unbalanced rotor. Note this hum while inspecting motor in operation; check for cause later, while making inspection of parts.

Note — VIBRATION. If excessive, this may be caused by either misalignment between shafts of motor and driven machine, or through transmission of vibration in driven machine to the motor. Run motor disconnected for check. *If vibration follows motor repair,* it's probably due to out-of-balance rotor.

Listen for — RAPID KNOCKING. May be caused by misalignment, with shoulder of shaft pounding against bearing end; realign set . . . and note this knock, check bearings when making inspection of parts.

NOTE: if excessive vibration, knock, or squeal follows re-assembly of motor, cause may be incorrect axial adjustment for float.

Look for — EXCESSIVE SPARKING OF BRUSHES. Check for cause when motor is taken down for inspection.

3 THEN CHECK THE PARTS

If time permits, you'll want to give detailed inspection to *every* motor that's been in strenuous service these past years. (You may be able to work this into your regular production schedule. Set up a system so that the electrical department may be notified whenever a machine is to be down. Disassembly and inspection of motors can be done then.)

And in cases where *history* of the motor or its *operating characteristics* indicate the likelihood of present or future trouble, you'll surely want to take a close look at the parts themselves.

A. FIRST — disconnect motor leads and uncouple motor from driven unit.

B. THEN — if excessive hum was noted while motor was in operation, use feeler gauge to check air gaps between rotor and stator. Difference of more than 20% indicates overworn bearings, sleeves, or journals. Check bearings as indicated below.

C. REMOVE end housing and lift rotor out, using a sling if rotor weighs over 75 pounds. If rotor is dirty, clean it with air hose (pressure not over 30 lbs), bellows, or vacuum cleaner, or swab it with non-inflammable solvent.

D. INSPECT rotor for abrasion; corrosion; discoloration (caused by overheating.) In squirrel cage motor, check also for loose or broken rotor bars.

E. IF ROTOR or armature is the wound type, check for loose banding. If any looseness is noted, band with new wire before putting motor back in service. If band assembly has not failed extensively — perhaps only a solder failure at one or two clips — repair can usually be effected simply by resoldering. Major rebanding, however, is a job for experts.

F. CHECK INSULATION — As motors get older, or as they operate continuously at high temperatures, insulation on coils tends to become brittle. It may start flaking off, cutting its insulating value. This may not affect motor performance seriously *except* that it may lead to short circuits or grounds, excessive vibration (out-of-balance rotor), or clogging of the air vents (leading to overheating) or abrasive wear from fallen particles. SO — check insulation visually . . . see whether pieces of insulation have torn or flaked off . . . and also make a megger (megohmeter) test. For a clean, dry motor at 75°C, insulation resistance in megohms, according to the American Standards Association, may be found by the formula:

$$\frac{\text{Rated voltage of motor}}{\frac{\text{Rating in KVA}}{100} + 1000} = \text{Insulation Resistance in Megohms}$$

G. CHECK BEARINGS — to remove ball bearings, use a puller, applying pressure to the inner race only, maintaining uniform pull all around, to avoid distorting the bore of the race.

Check bearings for excessive wear, scoring, or pitting.

To examine *anti-friction bearings,* first clean them thoroughly with kerosene to remove all old grease and dirt particles; then hold inner race and rotate outer race, feeling for roughness of action and listening for noise.

Inspect sleeve bearing clearance with feeler gauge. Normal clearances may be computed this way: take 0.003" as the basic tolerance . . . then add 0.001" for each inch of shaft journal diameter. Inspect journal surfaces; if scoring seems excessive, consider replacing.

If bearing shows no excessive wear, the hum of the motor in action may result from out-of-balance rotor or armature. Check this on parallel bars.

H. CHECK for cause of sparking. Check mechanical condition of parts. (For details, see Reconversion Inventory Kit, offered below.)

4 NOW MAKE THE APPRAISAL

With all the facts in hand — history, operating characteristics, condition of parts — your electrical department will be best prepared to assign this motor to its new role in reconverted production. Use check list forms like this —

RECONVERSION INVENTORY CHECK LIST
FOR ELECTRIC MOTORS

1. History of Motor
2. Operating Characteristics
TEMPERATURE—BEARINGS
VIBRATION
NOISE (HUM)
NOISE (KNOCKING)
3. Detailed Inspection
AIR GAPS
ROTOR
BEARINGS
INSULATION
COMMUTATOR
BRUSH POSITION
BRUSHES
COILS
TO BE FILLED OUT BY ELECTRICAL DEPARTMENT

for easy inspecting and appraising. Your nearby Allis-Chalmers district office or distributor will supply free copies of this Check List in whatever quantity you require.

CENTRIFUGAL PUMPS, V-BELT DRIVES, NEED INVENTORY TOO!

To speed your Reconversion Inventory of the most common industrial units, Allis-Chalmers has prepared a Reconversion Inventory Kit covering Electric Motors, Centrifugal Pumps, and V-Belt Drives. No big package, this kit is simply a set of Fact Sheets and Check Lists covering each type of unit, with suggestions for inventory procedure as outlined in these pages, but in somewhat greater detail.

A 1901

GET THESE FREE FORMS

For your supply of Reconversion Inventory Kits, covering motors, pumps, and v-belt drives, call your nearest Allis-Chalmers district office or distributor or write Dept. 403, ALLIS-CHALMERS MFG. CO., MILWAUKEE 1, WIS.

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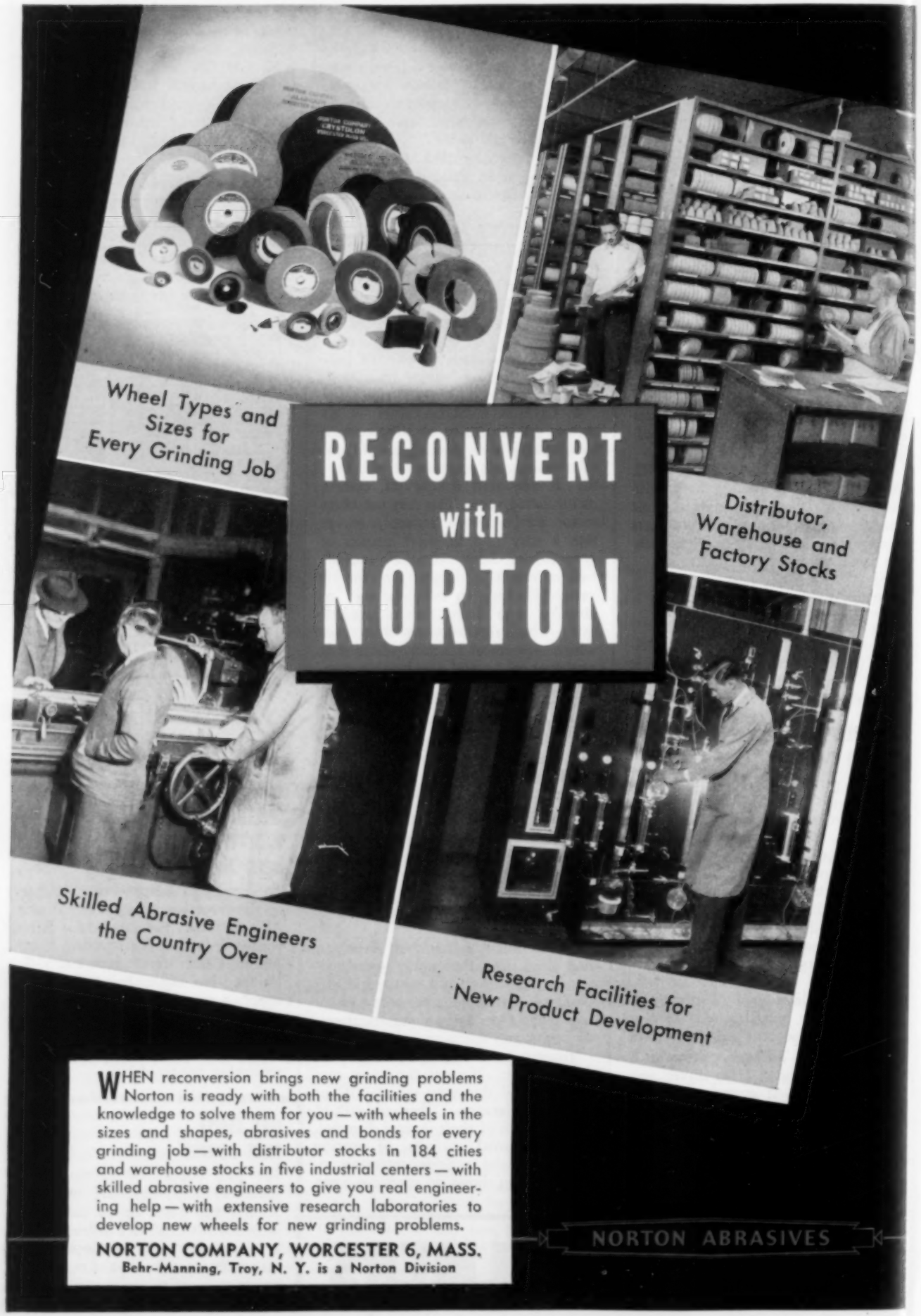
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NORTON ABRASIVES

ON THE COVER

THE aerial view shows Soledad Mountain and the mill and tailings pond of the Golden Queen Mining Company, Mojave, Calif. This property has a 425-ton cyanide plant, and was the state's eighth largest gold producer in 1942. The domestic gold-mining industry is looking forward to a prosperous era following the limitations placed upon it during the war period. In normal times such as 1940 the value of the total United States output reached $210,108,-700, based upon the established price of $35 per ounce, making it the leading mineral product that year. Copper came second, with a value of $205,453,-000; and iron third, with $189,086,800. The picture was taken by Spence Air Photos.

•

IN THIS ISSUE

IN THE article titled *Ordeal at Sea*, Robert G. Skerrett recounts the epic story of the aircraft carrier *Franklin*, miraculously saved by the heroic men of the U. S. Navy after being turned into an inferno by Jap bombs. Instead of going to the bottom of the sea, she steamed back home under her own power to be made fit again at the New York Navy Yard in Brooklyn. The unsurpassed facilities of that largest of our naval building and repair bases are described.

•

LISTED as a rare metal 50 years ago, vanadium has since then been put to widespread use. A pound or two of it added to a ton of steel produces an alloy of extreme toughness and resistance to fatigue. Much of our domestic vanadium comes from a mine near Rifle, Colo., where the ore occupies the voids between the tiny grains of a sandstone formation. The United States Vanadium Corporation has been very busy there during the war, as described in an article starting on page 260.

•

WHEN carried in a stream of compressed air, soft particles of corncob grits and rice hulls will clean many metal parts thoroughly without damaging or even scratching highly polished surfaces. Extensive experiments with the new technique were conducted at the U. S. Department of Agriculture's Northern Regional Research Laboratory and are described by two of the men who directed them. (Page 268).

•

COULD O. Henry, who called New York City "Bagdad on the Subway," return to life today he would marvel at the present proportions of both the city and its underground railway system. J. F. Nesbitt, a daily subway rider, tells us about the cavernous transportation network in an article starting on page 265.

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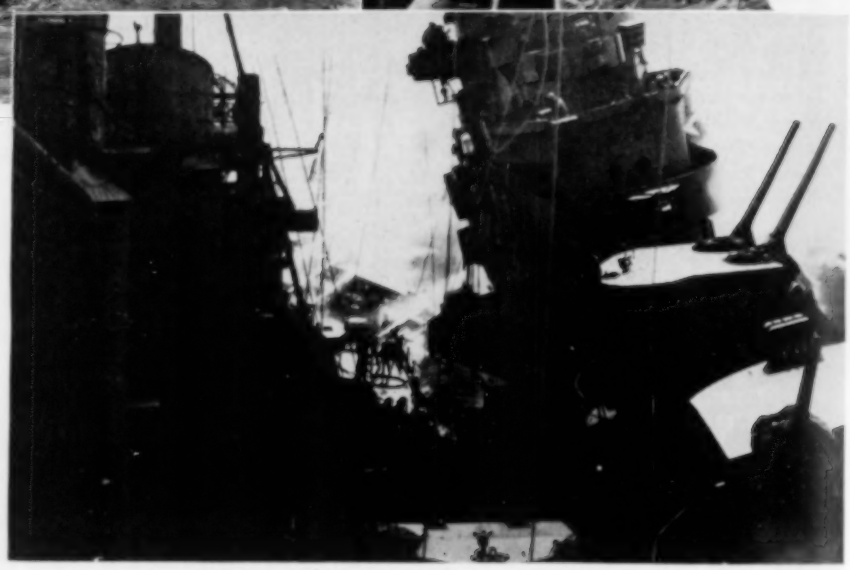
Ordeal at Sea

—the Story of the Carrier "Franklin"

Robert G. Skerrett



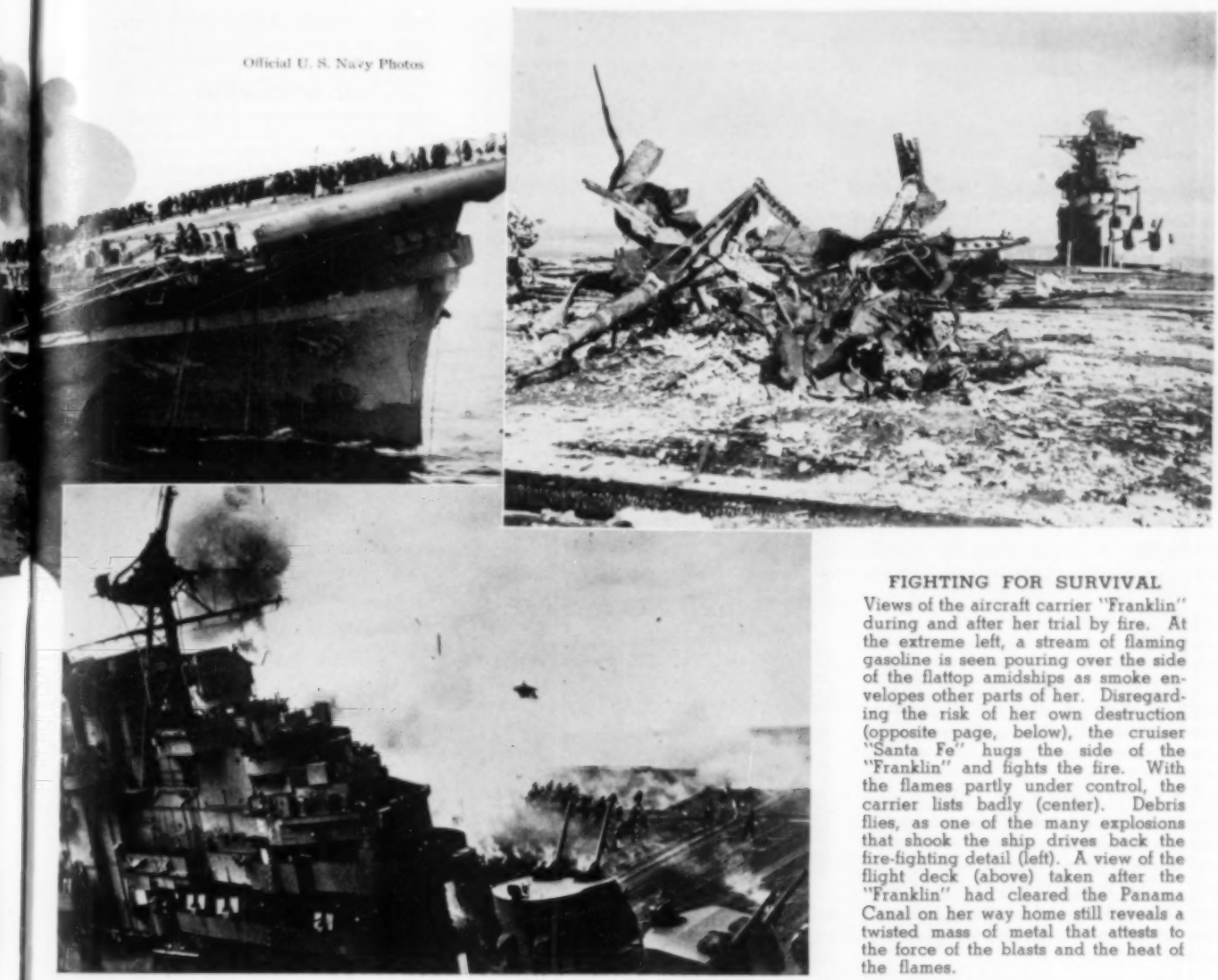
WHEN the *U.S.S. Franklin* nosed her way into a dock at the New York Navy Yard in Brooklyn last May she appeared as a "fighting lady" indeed, but a woefully damaged one. Tattered and seared and structurally a mess of twisted and shattered steel for much of her length above water, she gave ample cause for wonderment how she had escaped a grave on the bottom of the Pacific. Instead, with only a minimum force aboard to man her, she had covered more than 12,000 miles to reach the eastern seaboard of the United States and the Navy's greatest building and repair base.

The story of that well-nigh incredible accomplishment is the record of the intrepid men that faced death for long and exhausting hours to quench the flames that ravaged the carrier and caused the death of 341 of the members of the ship's company that engaged in that battle. But the total sacrifice among her complement of more than 2500 officers and bluejackets, exclusive of the air arm aboard, was 771 lives and more than 300 wounded. In the words of an official naval news release after the arrival of the *Franklin:* "She had lost a greater number of her men and sustained more battle damage than any ship ever to enter New York Harbor under her own power."

The flattop, mistakenly dubbed "Big Ben" by her personnel, was named after a Civil War battle fought at Franklin, Tenn., in the fall of 1864. The ship is of the *Essex* class of aircraft carriers. She has a length of 856 feet, a beam of 110 feet, and a displacement of 27,000 tons. Down deep in her great body are boilers and engines of such stupendous power that, when working at maximum capacity, they are capable of driving the vessel at a speed of around 30 knots. This is not merely for maneuvering and tactical purposes, but to help induce an air movement strong enough, together with the initial speed attained by an airplane on the flight deck, to lift the plane clear and to start it on its flight. Therefore, when possible, the carrier heads into the wind so as to add that lifting force to those resulting from the speed of the ship and of the plane as it runs forward on the deck. What is not known is that a carrier, with her engines reversed, can also back at high speed. When a typhoon damaged the bow of the *Hornet* so that planes could not take off as they would normally, the vessel was swung around stern first toward the wind and thus given sufficient headway to permit of safe "backward take-offs" for the time being.

The flight deck of a carrier is her weather or upper deck, immediately below which lies her gallery deck with projecting sponsons, interconnected by runways, in which are mounted innumerable antiaircraft guns. Then comes the main or hangar deck, which also has some sponsons for rapid-fire guns and may house 80 or more fighters, bombers, and torpedo planes. On the same level are workshops where mechanics and ordnancemen overhaul the air-

Official U. S. Navy Photos



FIGHTING FOR SURVIVAL

Views of the aircraft carrier "Franklin" during and after her trial by fire. At the extreme left, a stream of flaming gasoline is seen pouring over the side of the flattop amidships as smoke envelopes other parts of her. Disregarding the risk of her own destruction (opposite page, below), the cruiser "Santa Fe" hugs the side of the "Franklin" and fights the fire. With the flames partly under control, the carrier lists badly (center). Debris flies, as one of the many explosions that shook the ship drives back the fire-fighting detail (left). A view of the flight deck (above) taken after the "Franklin" had cleared the Panama Canal on her way home still reveals a twisted mass of metal that attests to the force of the blasts and the heat of the flames.

craft and keep their fighting equipment in perfect order. Under the heavy hangar deck are stored fuel oil for the boilers, high-octane gasoline for the flying machines, various types of ammunition, and many other things that are considered "restricted" when information is sought for publication.

Small gasoline tractors, which can be maneuvered like agile ponies, are used to push or pull the planes to the required positions; but 'tween decks they are handled by big plunger-operated elevators. The planes may be loaded with bombs, torpedoes, ammunition, and high-octane gasoline either on the hangar or the flight deck, where their engines are turned over at warming-up speeds from time to time to have them ready for instant use. On the flight deck, the waiting craft are usually grouped well aft to give a long runway, but they may have to be shifted forward to clear an area at the stern for returning airplanes. Each is quickly brought to a halt after alighting by arresting cables stretched across the deck and ingeniously arranged to check the high speed without injury to the plane.

Imposing as a large carrier may loom among other big battlecraft, she is structurally a lopsided vessel, and this characteristic of her modeling is emphasized by the cluttered "island" which is placed, as a rule, midlength of the flight deck and on the starboard side. This narrow, towering superstructure—flippantly spoken of as "City Hall," is the administration and navigational center of the craft. It is the seat of authority, with plotting rooms, charthouse, bridges that command wide fields of observation and the sweep of the flying deck, communication centers, signal stations, control rooms, and emergency quarters for some of the officers who are continually on duty in combat areas even during their periods of so-called rest. This island is therefore the bull's-eye for any bomber that may be able to get through the protecting screen of fighting planes and ack-ack fire to hit the flattop. These details, while general, are specifically applicable to the *Franklin*, and will make clearer what happened on March 19 when the ship was faced with imminent annihilation.

About an hour after dawn—at 7 a.m., to be exact—the carrier had sent an advance flight of fighters into the overcast sky. Those planes were the vanguard of a strike at the Jap naval base near Kobe where a remnant of the Imperial fleet had sought a haven. The *Franklin* was headed westward and was less than 60 miles from the Island of Shikoku. Seven minutes later, a single enemy bomber dropped out of a low-lying cloud at a speed of several hundred miles an hour to find the great flattop moving just ahead of him. At a height of less than 100 feet the Jap leveled off and swung over the carrier's flight deck, dropping a 500-pound bomb on the starboard side just forward of the island. Then, heading toward the stern, he released a second charge in the midst of 30 bombing planes assembled there for the take-off. The foe had done his work before a single antiaircraft gun could be brought to bear upon him; but it is some

THE AFTERMATH

Below—transferring survivors, including some of the injured, from the "Franklin" to the "Santa Fe" standing by at the right. Left—exhausted by the shock of repeated explosions and their fight against the flames, crewmen of the stricken carrier rest aboard the "Santa Fe."

satisfaction to know that the hostile craft was shortly afterward sent splashing into the sea by fighters of the *Franklin's* combat air patrol.

The first of the Jap's armor-piercing bombs detonated beneath the flight deck on which Helldivers were spotted ready for dispatch, and the second detonated against the heavy plating of the hangar deck where numerous planes, fueled and armed, were waiting to be raised to the flight deck. These were blasted into bits with their personnel; and the high-octane gasoline from their fuel tanks, instantly scattered far and wide, added raging flames to the rapidly spreading inferno. An official news release gives us this picture of what followed:

"Many major explosions succeeded the initial blasts. Large bombs exploded and threw men and planes the length of the ship. Smaller bombs, rockets, and machine-gun ammunition killed dozens of men who had survived the first explosions. Many tons of bombs and ammunition exploded aboard the carrier, and the resulting fires were fed by thousands of gallons of aviation gasoline. The whole after end of the carrier's flight deck had become a mass of flames and smoke. Airplanes disintegrated, as did their pilots and crewmen. Aviation gasoline poured over the sides of the hangar deck like a blazing Niagara. Bombs, rockets, bullets, splinters of wood and steel fell all around survivors who hugged the decks for safety. There was no panic.

"When many of the ship's regularly assigned damage-control parties were either killed or trapped by flames, volunteer fire-fighters took charge. It was not uncommon for a pilot, a mechanic, a ship's officer, and a steward's mate to be manning the same hose. Everywhere, the slightly wounded and those who had escaped injury fought desperately in the face of exploding ammunition to bring the fire under control." In short, the men kept up the struggle until they dropped from exhaustion. But, as is so often the case in situations of extreme peril, a man here and there with the gift of leadership set an example of intrepidity and drew to him the support and response of others. The stories of the outstanding figures of this kind aboard the stricken carrier have been told in detail as they deserve and need not be repeated here.

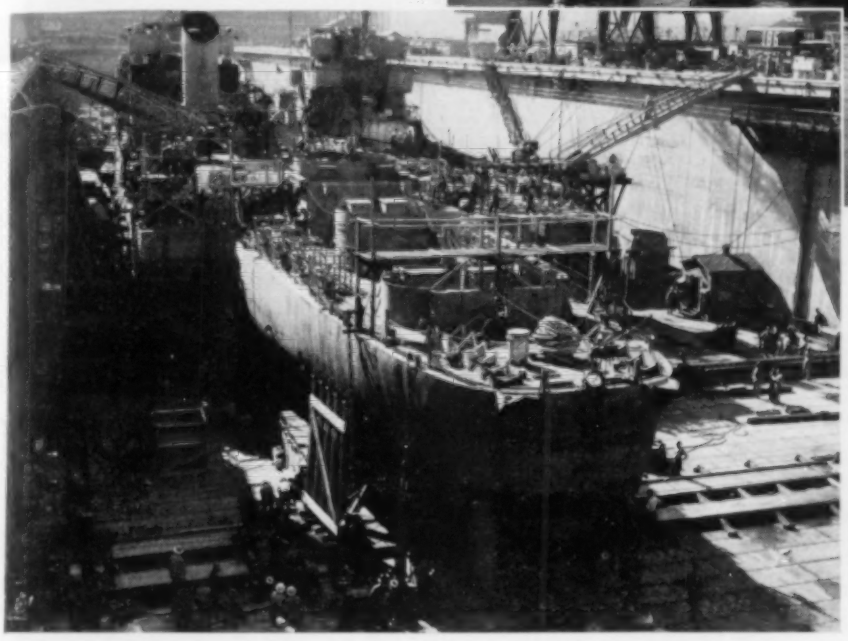
During the first hour after the *Franklin* was hit, conditions aboard of her grew increasingly grave; but, nevertheless, damage-control parties succeeded in flooding some of the magazines below decks, sometimes even when hot fumes were issuing from them. Around 9.30 a.m. the light cruiser *Santa Fe* came up alongside to remove the wounded and to help fight the flames with her fire pumps and hose, although her position entailed great hazard. When one of the carrier's forward 5-inch gun mounts caught fire and an explosion threatened, the *Santa Fe* drew away and suspended rescue operations until that menace had passed. Hundreds of survivors from the *Franklin* were picked up by destroyers patroling the area, two of those vessels actually rescuing more than 600 of her personnel.

The fires, the heat, and the wracking effect of the explosions all contributed to the wrecking of the carrier's structure, her means of communication, her many hundred miles of electric conduits, and to the temporary impairment of her motive power. The men down in her boiler and engine spaces rendered heroic service and stood to their stations until overcome by excessive heat or ordered topside when they could no longer serve below. When that stage was reached, the engines were set for low speed and left to run as long as the untended boilers would furnish motive steam.

Early in the afternoon of March 19 the flames were brought under control. Then efforts were made to restore order as far as it could be done by throwing overboard all wreckage on the flight and hangar decks that could be moved by the means at hand. Because of the water poured into her, the ship had a heel to starboard of about 14°, and there was the possibility that wind pressure against the towering superstructure might increase that angle and invite disaster. The list could be lessened by shifting water ballast to equalizing tanks on the opposite side of the vessel, but the valves provided for that purpose could

THE NEW YORK NAVY YARD

Views of the establishment in Brooklyn that grew during the war to the largest navy yard in the world. It is there that the "Franklin's" wounds are being dressed. At the right is a night scene with a dock-side crane swinging into position alongside a Navy destroyer. In the background is the giant hammerhead crane that can lift 450 tons. The other picture shows parts of two damaged destroyers before they were joined to make a new ship. In the foreground is the after section of the "Holder," which is being shifted left to line it up with the forward section of the "Menges."



no longer be controlled from the flight deck. Unmindful of the risks and difficulties, men worked their way into the depths of the craft where the valves were located, operated them, and brought the flattop back to a nearly level keel. Later, damaged guns and other useless heavy weights were jettisoned from her starboard side to effect her complete readjustment. Then the heavy cruiser *Pittsburgh* began towing the *Franklin* eastward at a snail's pace, but each mile moved her farther beyond the reach of hostile bombers who continued to attempt to strike her but whose efforts were frustrated by her few remaining undamaged weapons and by the fighter planes which circled protectively above her.

By the morning of March 20 the engineering force had one of the fire rooms operating, and the steam from the boilers added 2 knots to the three possible under the *Pittsburgh's* tow. During the same day more boilers were put in service and steam enough raised to drive the flattop at a speed of 14 knots. The tow line was then cast off, and the carrier proceeded under her own power. But she was otherwise in bad shape. There was no electric energy, and but little food was available from her stores. A small walkie-talkie, powered by electric batteries, was her only radio resource. Her steering gear was completely wrecked, and she could not be kept on her course except by alternately jockeying her port and starboard propellers.

But to quote an official source: "The courage and determination of the men who manned the ship pulled her through. The skeleton crew which had been kept aboard worked day and night to insure that the ship would stay afloat. So well did they do this job that the carrier worked up to 23 knots under her own power. On March 21, the *Franklin* reembarked 300 of her men from other ships that had picked them up. To an offer of additional crewmen, food, and equipment, the carrier's walkie-talkie radioed back: 'We have plenty of men and food. All we want to do is to get the Hell out of here'." The day following, the flattop, accompanied by a cruiser-escort, headed homeward, stopping briefly at an advance base in the western Pacific and then making port at Pearl Harbor for a few days rest before beginning the long run to the Panama Canal and thence northward to the Port of New York, a total journey of 38 days from the battle area.

The *Franklin* was built by the Newport News Shipbuilding & Dry Dock Company at Newport News, Va., was launched October 14, 1943, and commissioned January 31, 1944. She was constructed in about 17½ months, and that remarkably fast work has set a standard of performance for the men who are now repairing her. It is estimated that at least seven months will be required to make the great craft fit again for combat, and the job will probably cost around $45,000,000. A large sum, indeed, but $30,000,000 less than would have to be expended if the vessel were built anew. To put the ship in proper shape will necessitate the labors of 4,000 men working day and night seven days a week, or about 6,500,000 man-hours. This is explained by the fact that 80 percent of the carrier's structure above the hangar deck must be reconstructed and the entire craft rewired.

Most of us have a hazy idea of the complex nature of the work done at a base such as the New York Navy Yard, which both builds and repairs the nation's fighting ships. The magnitude of these efforts at that station since the beginning of the war has been great and has called for a maximum of 69,000 workers, men and women, of a wide range of ages and diversity of qualifications. At the time this article was written, just before the cessation of hostilities, Rear Admiral Freeland A. Daubin, U.S.N., Commandant of the yard, explained that its carrier program "alone requires more than 5,000,000 man-days. This program involves constructing four flattops, including the supercarrier *Franklin D. Roosevelt*, and the reconstruction of the *Franklin*. The other carriers are the *Kearsarge*, launched May 5, and the *Oriskany* and *Reprisal*." In addition to the work underway, there have been constructed since December 7, 1941, the *Bennington* and *Bon Homme*

USES OF PNEUMATIC TOOLS

Modern shipbuilding and ship-repair work call for the use of thousands of air-driven tools of many kinds, and they have contributed importantly to the imposing wartime records made in both government-owned and private establishments. These pictures show typical shipyard applications of several types of pneumatic tools. 1– A Size 534 impact wrench quickly runs up nuts to bolt side plates together. 2– Driving ⅞-inch flush rivets in hull plating with a 6-A riveting hammer. 3– This man evidently enjoys drilling holes through steel plate with a "Multi-Vane" nonreversible drill. 4– Beveling a seam preparatory to welding. 5– Rough grinding a propeller blade.

Richard—flattops, each of 27,000 tons; the *Iowa* and *Missouri*, battleships of 45,000 tons each and the mightiest of their class in service; as well as a considerable number of large landing craft.

Outstanding repair jobs have involved two foreign and two United States battleships: the British *Malaya*, torpedoed in 1942; the French *Richelieu*, shelled in North Africa the same year; the *South Dakota*, long known as "Battleship X," which limped back through the Panama Canal after its memorable operations in the southwest Pacific in the fall of 1942; and the *Texas*, which was damaged last year off the coast of Normandy. Among other famous fighting craft

repaired there was the cruiser *Marblehead*, "bombed to hell" in the Java Sea in February, 1942. That heroic vessel made a cruise half way round the world, crippled as she was, to have her scars of conflict treated. Three British cruisers, the *Glasgow*, *Phoebe*, and *Ajax* also were restored after they had been damaged by bombs and torpedoes; and the French cruiser *Gloire*, badly hurt, was made fit again for combat service. Reviewing what has been done at the yard in the war years, Admiral Daubin has noted: "The number of ships repaired and altered has increased from 350, in 1942, to 1586, in 1944. The manpower requirements for this production record rose from 2,479,830 man-days in 1942 to 6,591,203 man-days in 1944; and the demands of the current year are even greater."

How the yard has further helped to cheat our foes of their "victims" is strikingly exemplified by two very badly damaged destroyer escorts—the *U. S. Holder* and the *Menges*—which were combined by modern ship surgery to form a single efficient craft. The *Menges*, while on convoy service in the Mediterranean, was struck in May, 1944, by torpedoes from a German submarine. The explosions tore away the aftermost third of the vessel, killing and wounding 51 of her personnel. The Coast Guard officer in command, instead of abandoning ship, set his damage-control force to work to keep the surviving two-thirds of the boat afloat while a British tug towed it to a nearby port. The *Holder*, also hit by torpedoes, was similarly kept from sinking and was moved into Algiers where she was temporarily patched up before being towed to the New York Navy Yard.

The destroyer-escorts happened to be sisterships, and when both were in dry dock, placed side by side, the good after end of the *Holder* was cut free and the ragged after section of the *Menges* was sheared at the right point, just like slicing a loaf of bread. Then the stern of the *Holder* was shifted laterally until the plating and exposed structural features of the two vessels were in exact alignment and could be bound together by welding. As the composite craft was more *Menges* than *Holder* she was officially listed as the *Menges*, although the *Holder* section gave her her driving power. As a matter of information, the work on a battle-damaged ship is not confined to restoring her as she was before combat, but almost always includes changes and improvements—the lessons learned in conflict showing how a craft can be made more efficient and formidable for the next fight.

The New York Navy Yard epitomizes in its own way how we have developed as a nation; and just a single historical contrast will make that clear to us. A short while before the close of the administration of John Adams—the second President of the United States—we were confronted with a great national exigency because of attacks upon our commerce by France. Benjamin Stoddert, Secretary of the Navy, induced Congress in February, 1799, to appropriate $1,000,000 for six of the largest ships of war and, incidentally, to create a permanent Navy. To construct those vessels, some of that money was applied to the purchase and improvement of sites for six navy yards.

As we look at it today, $1,000,000 is a trifling amount, and yet for but $40,000 the Government then obtained 42 acres on the Long Island side of the East River as a location for the New York yard. On the ground was a shipyard of established reputation, and transfer of title was effected in February, 1801. Now, the base embraces approximately 290 acres, which cost less than $500,000. Of course this sum represents but a fraction of what has been spent over the years and latterly in expanding the establishment and in outfitting it for the vast volume of work required of it—work of the highest standard in its different fields of activity.

As a comprehensive description of the facilities would take up too much space, let it suffice to say that the yard has two building ways long enough for the biggest fighting craft. There are also two construction dry docks in which can be built ships of immense size and from which they can be floated, not launched, when they are well advanced towards completion. There are other large but older dry docks on the property. Towering cranes move back and forth on wide-gauge tracks to handle heavy weights entering into the construction of the vessels in the building docks and in the outfitting slips. One monster hammerhead crane, which is said to be preëminent among aids of this kind, is capable of taking a load of several hundred tons. Standard and narrow-gauge tracks branch throughout the yard for a combined distance of nearly 30 miles. Within its confines are something like 300 buildings and shops of varied sizes such as are needed in establishments that engage in the designing, construction, outfitting, and repair of vessels.

Work at naval bases differs in some respects from that in private plants, because national security and not profit is the dominant purpose. For example, the force assigned to the building of a ship may, at a moment's notice, be reduced by sending some of its members to another vessel to speed her completion; or a damaged craft arriving for quick repairs and refitting may for the time being be a more pressing task. This flux may not be economical, but it is the only way in which an emergency can be properly dealt with and our fighting units made available where and when they are most needed. In the New York Navy Yard the authorities have done everything to train inexperienced people to become helpers for expert workers of whom there was a shortage. And, as in many industrial fields, women employees have made excellent records for themselves in handling shop assignments that do not require masculine strength.

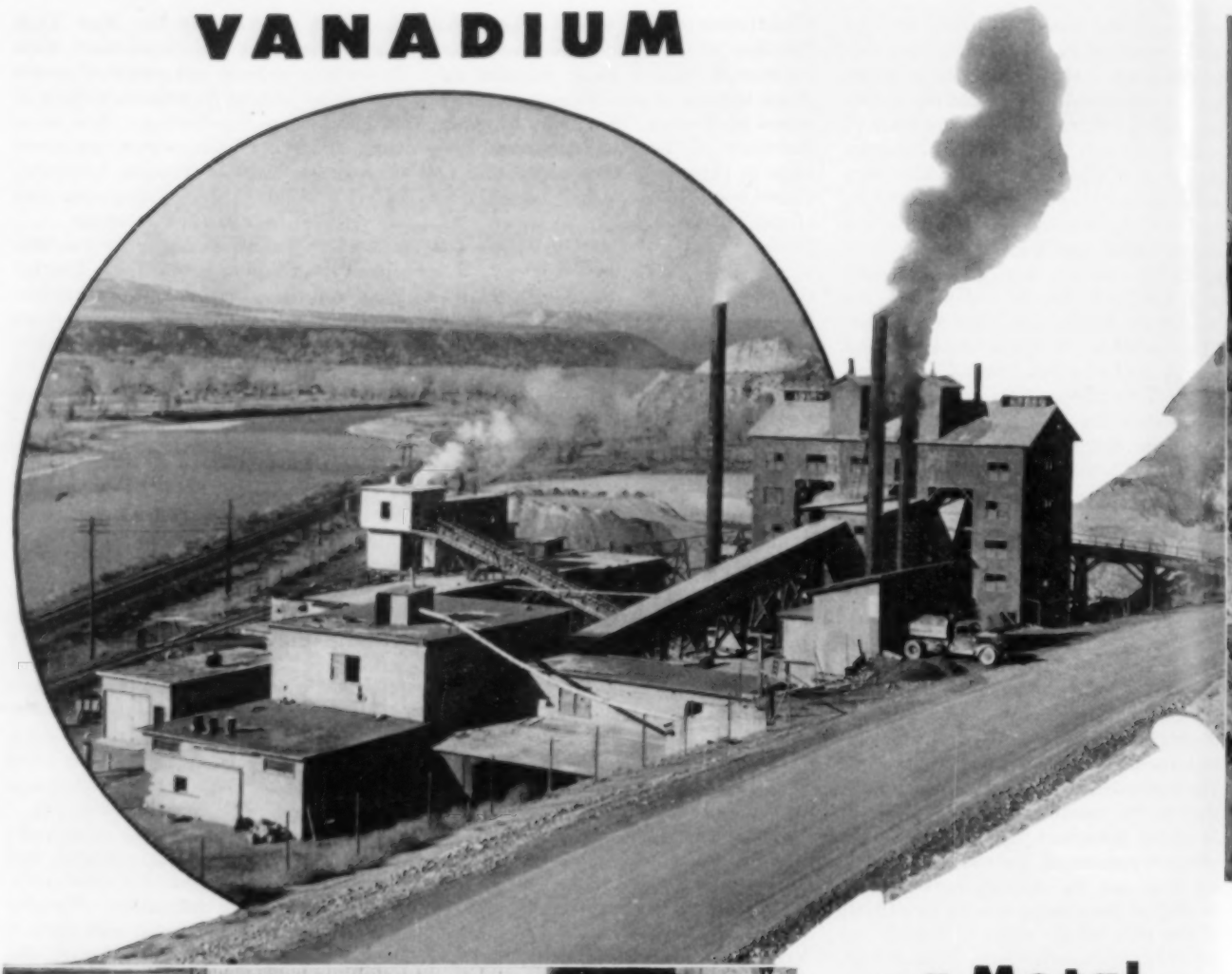
Much of the work done in the machine shops is of a nonstandardized description, and there is no chance for production-line operations. Yet each job must be done well, and as fast as possible. Time-saving is sought everywhere, and of this there is evidence in the equipment and the tools used to assist labor.

Air power plays a big part in this program. The staccato taps of pneumatic riveting hammers are heard continually at the building ways and dry docks and at the outfitting slips; and aiding them are air-operated holders-on for bucking up or backing the rivets as they are driven. Under some conditions pneumatic jam riveters are used, particularly where the rivets must be driven in close places. To the audible activities of these tools are added those of compressed-air chipping and scaling hammers. Portable air tools drill and ream holes in steel plates. Tube-rolling and tapping machines also are air powered.

Then there are pneumatic close-quarter machines for drilling, reaming, and tapping in confined spaces of steel structures that impose difficulties. Portable air grinders for horizontal and vertical application are employed for surfacing metal plates and bodies, for removing excess material, or to impart a better finish. Light, portable air-driven wire-brush machines are used for cleaning metal surfaces. In assembling and fitting members, preparatory to binding them together with rivets, air-operated impact wrenches run on and off the nuts that help to hold parts together temporarily.

Pneumatic hoists serve machine tools in the shops and assist elsewhere in handling loads too heavy for men to lift. Carpenters are equipped with air-driven woodborers and saws, and painters are busy spraying protective coatings under the impulse of compressed air. Anybody at all familiar with work in a modern foundry—and the Navy Yard has one—knows that pneumatic sand rammers, core breakers, and chipping hammers have plenty to do there. In out-of-the-way places in ships under construction or in vessels laid up for repairs, air-motor-operated sump pumps are handy means of getting rid of water that may accumulate there during the months they are on the ways. The air for these multiple applications is furnished by steam- and electric-driven compressors having a total capacity of 55,000 cfm. On hot days the demand is large enough to draw upon the full capacity of all the machines.

VANADIUM



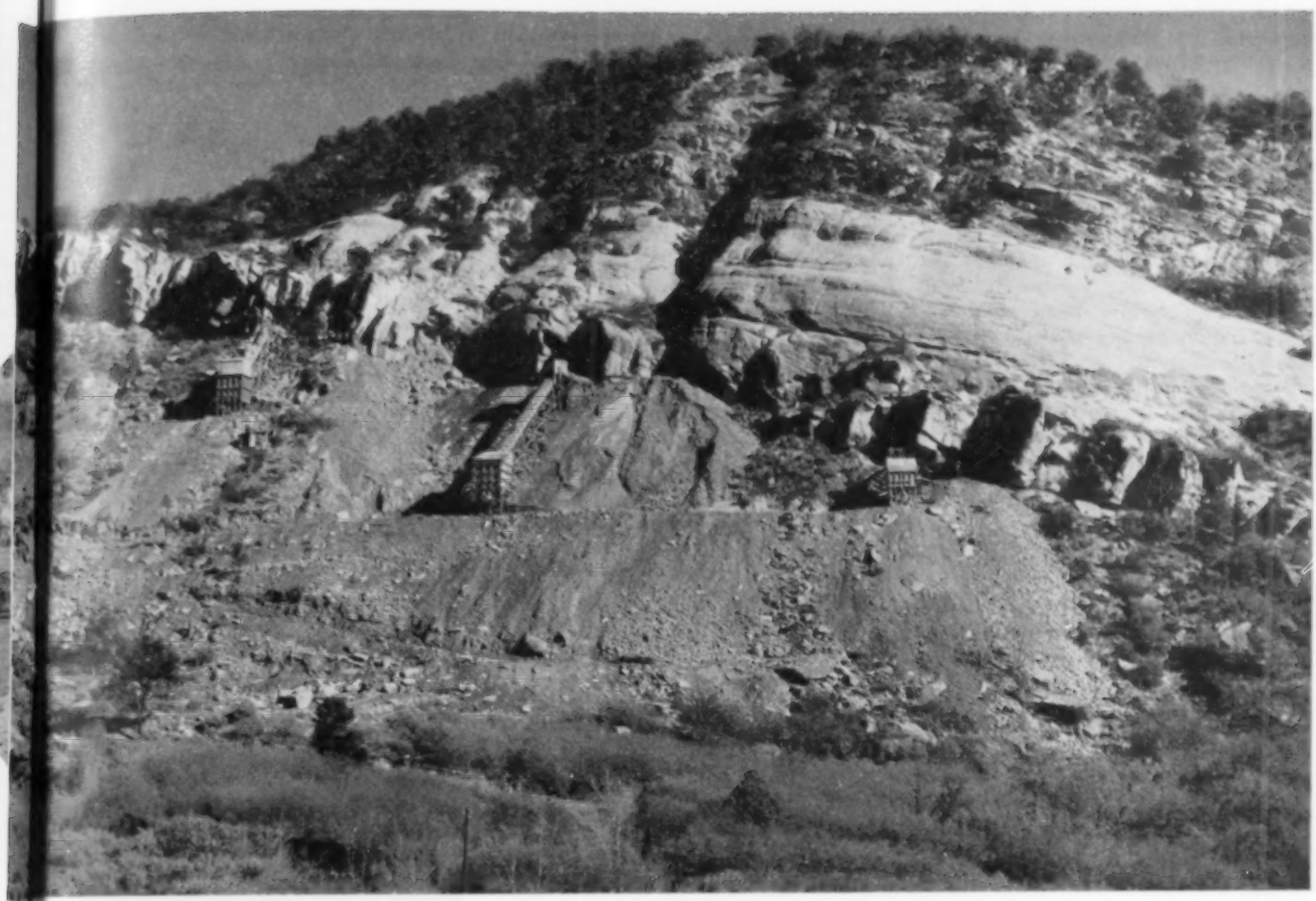
—a Metal Named for a Goddess

C. H. Vivian

Thos. J. Barbre Photos

GENERAL VIEWS

The vanadium-bearing mineral that is mined near Rifle, Colo., occurs in a sandstone layer. The picture on the opposite page shows it where it is exposed on the side of a valley cut by Rifle Creek. The first openings were made at this location, but present major mining operations are conducted through an adit about half a mile away. Ore is trucked 14 miles from the mine to a mill at Rifle (top of page), where the vanadium is extracted. At the left of the buildings is the Colorado River. The view just above shows one of the leaching tanks at the mill. There the soluble sodium metavanadate, obtained by roasting the ore with common salt, is dissolved in hot water. Subsequent treatment produces black metallic vanadium pentoxide, which is bagged (right) for shipment to one of two plants in the East that produces ferrovanadium.



THE story of the metal vanadium is one of the most romantic tales from the mineral kingdom. For 100 years from the time it became known, vanadium was merely a curiosity to savants. It was considered a rare metal, and ores that contained it were of interest only to collectors of mineral specimens. From that place of obscurity and uselessness it has risen in less than half a century to such eminence that nations at war covet it.

Early in our participation in the present conflict, vanadium was classed by the Army and Navy Munitions Board as a "critical" metal. Its export was prohibited and its use was restricted to the manufacture of essential materials for warfare. Appeals were made to the owners of all known domestic deposits to exploit them to the fullest possible extent. These efforts fortunately resulted in the production of such quantities of vanadium that the restrictions could be removed, and nonmilitary consumers have been free to purchase and employ the metal for the past eighteen months.

Ninety-odd percent of our vanadium output is used in alloying steel, being combined with other metals, notably chromium and manganese. Its particular virtue is that it toughens steel without impairing its hardness or ductility. Being resistant to abrasion, fatigue, and impact, vanadium steels find application in armament and in various machine parts, especially pistons, gears, axles, springs, connecting rods, drive shafts, crankshafts, etc. The element is also a component of the best grades of high-speed tool steels. Their toughness results from the uniform grain size imparted by the vanadium, making the metal structure homogeneous. It is usually added to the molten steel in the form of ferrovanadium in amounts of from 1 to 4 pounds per ton, and as it has a strong affinity for oxygen and hydrogen, its first action is to combine with those elements and, hence, to purify or scavenge the metal. The compounds thus formed go off in the slag, while the remaining vanadium forms a solid solution with the iron. Vanadium steels can be readily cast, rolled, or forged, are easy to machine, and have exceptional weldability.

Even the discovery of vanadium had its unusual aspects. In the year 1801, Andres Manuel Del Rio, professor of mineralogy at the Royal School of Mines in Mexico City, was making some laboratory investigations of a brown lead ore—really vanadinite, a lead chlorvanadate—from mines at Zimapan, Hidalgo. He obtained such unexpected reactions that he thought he had discovered a new element that was somewhat akin to chromium and uranium but differed from either of them. He gave it the name erythronium. Subsequently, a French professor, Collet Descosfils, examined some of the same ore and published an article stating that Del Rio's find was not a new element but only impure chromium. The Mexican professor accepted that decision and agreed that in all probability the ore was lead chromate.

In 1830 the Swedish scientist, N. G. Sefström, rediscovered the element in slag derived from the reduction of Taberg iron ores. Because some of its compounds produced solutions of beautiful colors, he called the new metal vanadium, after *Vanir* or *Vana*, the name of a race of gods in Norse mythology to which *Freya*, the goddess of beauty, belongs. Eminent chemists such as Wohler, Berzelius, and Sir Henry Roscoe studied the element without finding much practical use for it. Wohler showed that it was identical with Del Rio's erythronium, while Berzelius made the first detailed study of it.

Nearly 40 years later, Roscoe, whose name is perpetuated by the vanadium-bearing micaceous mineral roscoelite, proved that all the previous workers had conducted their experiments not with vanadium itself but with either a nitride or an oxide. He was the first to isolate the true element, which is a silvery-white metal with a specific gravity of

approximately 5.7 and a melting point of 3110°F. Before the value of vanadium as a steel-making alloy was discovered, some of its compounds were employed for making ink and for coloring fabrics and leather, but it remained largely a scientific curio.

In 1900 a professor named Arnold at the University of Sheffield in England started a chain of events that brought vanadium into its present position. Sheffield was the recognized world center of the fine-cutlery and tool-steel industry, and efforts were always being made to better its products. Professor Arnold experimented with various alloying agents, among them vanadium. He found that it vastly improved the cutting qualities of steel; but the information was of little commercial value because vanadium was then in the category of rare metals and cost more than gold.

The Sheffield industrialists didn't do anything about making vanadium more plentiful, but two resourceful Yankees did. They did it the hard way, by going out and looking for it along the highways and byways of the world, as prospectors have always done. They were a pair of Pittsburgh brothers, J.J. and J.M. Flannery. Somewhere they had heard that vanadium would do wondrous things for steel, and having been reared in the heart of the American steel region they had visions of making their fortunes if they could discover substantial deposits of vanadium-bearing minerals.

Although they were neither mineralogists nor trained prospectors, the Flannerys got some financial backing from among their friends and started the search. At an elevation of 16,000 feet in the Andes Mountains of Peru they located the richest vanadium ore that had yet been found. They were led to it by Antenor Rizo Patron, a Peruvian engineer who first recognized that it contained vanadium, so they called the mineral patronite. It is a black, slate-like material lying among shale beds and associated with carbon and sulphur. It contains up to 40 percent vanadium sulphide, 30 percent free sulphur, 14 percent silica, 4 percent iron, and various other elements. After burning off the sulphur, the vanadium-sulphide content of the richer ores is as much as 52 percent.

Even after finding the Peruvian deposit, the brothers had a hard time reaping any profit from it. They organized a company to produce vanadium, but learned that the Pittsburgh steelmakers were not eager to buy it because they were not familiar with its benefits. This necessitated a campaign of education. After the steelmen had been convinced of the merits of vanadium, they still faced the problem of extracting the mineral from the ore, as this had never been done on a commercial scale. The

Thos. J. Barbre Photos

Flannerys hired the best technologists they could find, threw in all the money they could raise, and succeeded in developing a suitable reduction process.

As soon as the effect of vanadium on steel became generally known, many research chemists became interested in it and brought about its use in the manufacture of various types of products. Vanadium steels were especially helpful to the rapidly growing automobile industry because they provided the latter with effective materials for certain parts of cars that were subjected to heavy-duty service. Henry Ford went so far as to make the cast-iron engine blocks of his Model T car with the aid of vanadium, thus producing a homogeneous metal that was probably at least partly responsible for the longevity of the power plant in that remarkable vehicle. There is no known instance of vanadium being employed in cast iron today, probably because it is considered too expensive.

For many years after the Peruvian deposits were opened up they furnished the greater part of the vanadium used throughout the world. In 1918, when it was in great demand for munitions of war, 85 percent of all the metal sold came from Peru. Other sources have been gradually developed, but that South American country normally still accounts for half the total output, with the United States second in importance. Vanadium is contained in some asphalts and petroleums, the crude oil from Venezuela being notable in this respect. Some ships that burn Venezuelan fuel oil are equipped to catch the flue dust,

DRILLING

Most of the drilling in the Rifle Mine is done with Jackhamers and Stopehamers, the former being mounted when required for drifting in development work. Left, a JB-5 Jackhamer is putting in a hole for taking up bottom. The other view shows an R-48 Stopehamer in operation. Being used to mine vanadium ore, vanadium-alloy steel enters into the manufacture of some of their parts of which toughness and high strength are demanded.

which is treated to recover the vanadium. Germany obtained her supply during the recent war from accumulations of slag from the blast-furnace reduction of iron ores. Swedish iron ores, which have been largely used in Germany, and also some German ores, contain from 0.3 to 0.7 percent of vanadium pentoxide, which explains Sefström's discovery of the element in Taberg slags. Incidentally, there is sound reason for the belief that the excellence of the iron and steel made from Swedish ores is attributable to their vanadium content.

Colorado and Utah are the principal vanadium-ore producing areas in the United States. Wartime investigations by the U. S. Bureau of Mines have indicated that there are several million tons of relatively low-grade material in Wyoming and Idaho, but so far no efforts have been made to develop it commercially. When the carnotite deposits in western Colorado and eastern Utah were originally worked some 30 years ago by a Colorado company to recover uranium and radium, it was learned that they contained vanadium, but the operators were then not interested in

that mineral. In fact, they considered it a nuisance and abandoned working faces that contained appreciable amounts of it in favor of other locations where it was absent, or not so prevalent.

The discovery of richer radium ores in other parts of the world put the Colorado radium producers out of business. Other interests thereupon acquired their mineral holdings and began mining vanadium. Among these was the United States Vanadium Company, which developed a newly discovered vanadium deposit near Rifle, Colo., where a mill was constructed. In 1926 these holdings were purchased by the Union Carbide and Carbon Corporation, which has since carried on operations through the United States Vanadium Company. Activities were carried on until 1932 when the ore supply at Rifle appeared to be virtually exhausted. At that time the mill was dismantled and moved to another location, where the corporation built extensive processing and housing facilities, as well as roads to reach the numerous sources of ore distributed throughout an area stretching as far away as 60 miles in three directions. Incidental to this phase of the work was accumulated some $300,000 worth of highway equipment.

When we began to prepare for war, the Government requested that vanadium production be increased as much as possible, so it was decided to reopen the Rifle property to mine low-grade ore that had been left in marginal sections of the old stopes. Some diamond-drill prospecting and underground work were done at the same time in the eastern end of the deposit. These operations disclosed the continuation of the ore structure easterly, and when workings were driven into this area it soon became evident that there was more ore available than had ever been taken out. Mining was consequently resumed, and a new mill of 200 tons daily capacity was constructed on the site of the old one.

The Rifle Mine is located 14 miles north of the town of Rifle, which is on the Denver & Rio Grande Western Railroad's main line between Denver and Salt Lake City. Ample housing accommodations are available there, including a residential section constructed by the Government to facilitate the wartime production program. The vanadium-bearing mineral exists in a sandstone formation that outcrops near the top of a ridge that has been cut through by Rifle Creek and whose summit is several hundred feet higher than the stream. The sandstone dips or slopes a little south of east at an angle of 16° to 32° from the horizontal, and its strike is generally east-west.

The ore-bearing rock contains several vanadium-oxide minerals. It does not occur in a vein, as the latter term is commonly understood. Instead, it fills the voids between the grains of the sandstone that incloses it. Geological evidence indicates that it was deposited concurrently with the sandstone and that the latter was formed under flood-plain conditions on a surface that had been previously eroded. The ore body varies from 0 to 35 feet in thickness and averages around 12 feet. Its vanadium-oxide content ranges around 1.6 percent, or 32 pounds per ton.

Mining operations were originally conducted at the western end of the deposit where the mineral was exposed on the east slope of Rifle Creek Valley. Adits were driven at several locations, all of them at lower elevations than the present workings. To gain access to the ore farther to the east, an adit was advanced southward from a point high on the north side of the ridge and some 3300 feet from the first openings. This intersected the ore body at right angles about 320 feet from the portal, and drifting was done both toward the east and west, opening up what is known as Zero Level.

As the dipping ore body was followed downward, another level—A Level—was opened up. Ore from that horizon was transferred to Zero Level through an inclined haulageway and taken out through the adit. As the ore was mined eastward during the recent wartime operations, the mineral-bearing zone developed a dip that carried it below Zero Level. To eliminate the necessity of raising it to that level, a new adit, at A Level, was driven during the past year and ore is now removed through that entry. While this was being done, electric-motor haulage was installed throughout the workings, doing away with manpower tramming.

The mining procedure is simple. Since all drifts are in ore they add to the tonnage and are made two or three times as large as they generally are. This provides plenty of room for double tracking where desired, and adds to the safety of working conditions. At 35- to 50-foot

SCRAPER LOADING

Some of the stopes in the mine have floors that slope sufficiently for the ore to flow by gravity to chute gates, where it is withdrawn into cars. Where that is not the case, the broken ore is slushed down with scrapers pulled by air or electric hoists. These pictures show an Ingersoll-Rand 2-drum hoist, set up in a haulageway, and the scraper it operates bringing down a load to a "Chinaman" chute where it will be dropped into the car spotted underneath it.

intervals, inclined raises or slots are driven upward along the slope of the ore body and stopes are opened from them by slabbing down the ore with explosive charges placed in 5-foot holes drilled with stopehamers.

Wherever the stope floor slopes sufficiently to permit gravity flow, the broken material is withdrawn through a 48-inch chute fitted with an arc-type gate. Where it is not steep enough, the ore is scraped down through a Chinaman chute on to a platform, where it drops through an opening into cars. The scrapers are operated by slusher hoists mostly electrically driven. They range from 5 to 15 hp. and are of single-, double-, and triple-drum types. Diamond-drill blast-hole drilling has been employed during the past year in one section where the ore body was of dimensions favorable to it. Holes are as much as 100 feet long, and when a series of them is shot, as much as 1000 tons of ore is slabbed down at a time. This drilling is done by a contractor. The Rifle Mine is unusual in that it is very dry. In fact, the water required for the operations is pumped from reservoirs in the valley below to a 24,000-gallon storage basin above the mine. The pumping head is around 1000 feet.

Although the rated capacity of the mill at Rifle is 200 tons daily, it is run at as much as 20 percent overload, and to provide this tonnage the mine production is maintained at about 225 tons a day. The ore is hauled to the mill under contract in 8- and 9-ton trucks and delivered either to storage bins or stock piles. Milling is chiefly a chemical process, the objective being to convert the vanadium content of the ore into soluble form, so that it can be leached out, and then into pentoxide V_2O_5, a product that is suitable for making the ferrovanadium used in steel plants.

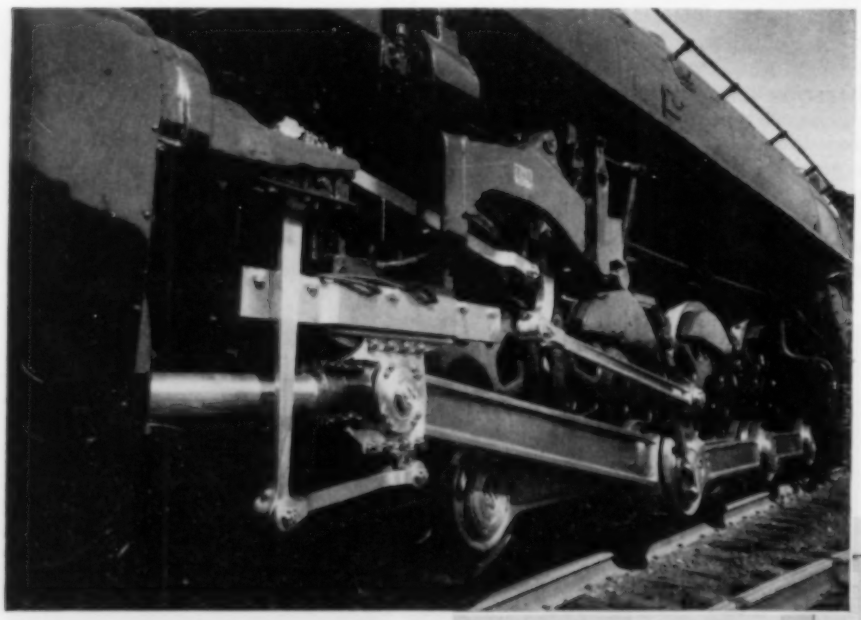
The first step is to crush the ore to release the vanadium-bearing material, and as the latter is in the interstices between the grains of the sandstone it can be liberated by reducing the ore to grain size, or a minimum of about 14 mesh. This is done in two stages: the material goes through a primary crusher, and then, after screening, the oversize is further reduced in a rod mill. Common salt—sodium chloride—in granulated form is added after primary crushing. Some other sodium compounds would serve as well in the chemical process that follows, but chloride is used because of its low cost.

This mixture is raised to the top of a Skinner roaster, a cylindrical iron-clad vessel 90 feet high, 18 feet in diameter, and having twelve hearths disposed vertically throughout its height. The material comes in at the center, and a series of rabbles pushes it first toward the outside walls and then back toward the center, thoroughly mixing it. It then falls through a central opening to the next level, and this is repeated until it reaches the bottom hearth. The furnace is coal-fired and operated under forced draft. At a temperature of about 1550°F. the vanadium combines with sodium to form sodium metavanadate, the chlorine content of the salt being released during the reaction.

As the metavanadate is soluble in water, the vanadium can now be readily separated from the sand. The discharge from the furnace is elevated to a cooling drag and quenched at the top to complete cooling. From there it goes to leaching tanks, where the sodium-vanadium compound is dissolved in hot water. This liquor is pumped to other tanks where sulphuric acid is added and the vanadium is precipitated in the form of sodium hexavanadate which, because of its distinctive color, is called red cake.

A relatively small amount of red cake is subsequently converted into 99-percent-pure V_2O_5 for use as a catalyst in the manufacture of sulphuric acid. This is done by redissolving it, adding ammonia to produce ammonium metavanadate, and heating the latter to drive off the ammonia. Most of the red cake, however, is processed through one or more steps to prepare it for the making of ferrovanadium for the steel trade. This consists of fusing the material, which has a low melting point. Fusing changes the product physically but not chemically, and it emerges as a black, metallic material which is sacked for shipment. It contains about 88-89 percent V_2O_5.

The final step in the production of ferrovanadium is carried out in either of two United States Vanadium Company plants in the eastern part of the country. At Niagara Falls N. Y., the work is done by electric furnaces, while the Goldsmidt thermit process is used at Columbiana, Ohio. The current price of ferrovanadium is around $2.70 per pound of contained vanadium.



TYPICAL USES

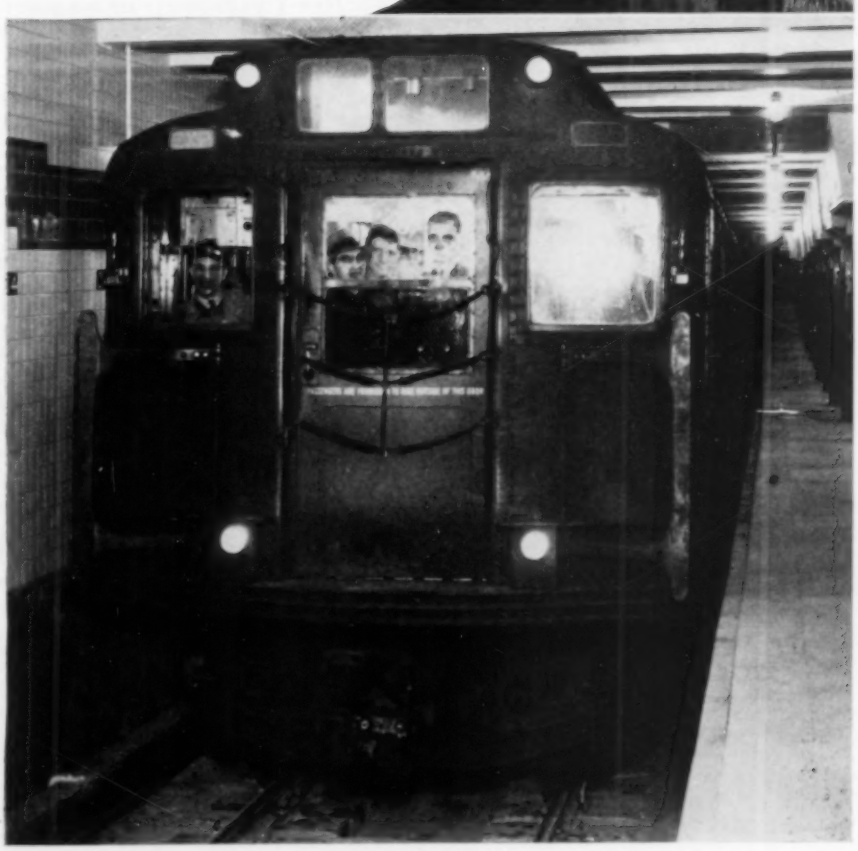
A 235-ton "Niagara-type" locomotive built by the American Locomotive Company for the New York Central Lines and designed to handle either freight or passenger trains. Manganese-vanadium steel was used for the main rods and side rods (above) and carbon-vanadium steel for the roller-bearing axles and some other parts. These vanadium-bearing steels combine high strength with exceptional ductility and toughness, easy machinability, and high resistance to fatigue.

Ewing Galloway Photo

East Side, West Side, Underneath the Town

J. F. Nesbitt

TWICE a day, with the routine regularity of one of nature's cycles, occurs a phenomenon that would have defied even the agile imagination of Jules Verne. In the short space of less than two hours each morning, a vast multitude of probably a million or more persons converges from all points of the compass upon an area of approximately 15 square miles. Seven or eight hours



RAPID TRANSIT

Since the first New York subway was opened in 1904, that railway system has become the greatest of its kind. Passengers are whisked to every part of the metropolis at a top speed of 45 miles an hour. Nowhere else can one travel so far for a nickel. Some riders who make the same trip each day acquire the uncanny habit of sleeping in their seats (if they get one) and always waking up at the proper stations. Certain trains bear distinctive lights that enable regular patrons to identify them as they approach a station. The motorman sits in a cubicle in one corner of the leading car (see view at the right) that is partitioned off from the passengers.

later the movement is repeated, but in reverse—the same multitude, now weary, fans out in all directions and is deposited at the points of inception.

But the remarkable thing about this migration is not so much its tremendous size as the manner of its accomplishment. In the area of its greatest concentration there are few outward or surface indications of its occurrence. Almost miraculously, the men and women of New York City's towering, 3-dimensioned business section appear at their allotted places of employment, perform their appointed tasks, and, later, just as miraculously disappear into a hole in the ground. Signs of underground activity—muffled subterranean rumbling and imperceptible vibration—reveal the answer, a unique and highly efficient passenger railroad.

Unhampered by cross currents of traffic or vagaries of weather, trains move in a labyrinth of tunnels extending through the very foundations of the metropolis and under rivers and massive skyscrapers—through solid rock, quicksand, and mud. At depths varying from a few to as many as 180 feet, passengers gaze with boredom at an unchanging scenery of blank walls and flickering lights, or nonchalantly read their newspapers, totally oblivious of their immediate location or its topography, unimpressed by the miracle that made it possible for them to be there.

This is assuredly no ordinary hole in the ground. It is an engineering achievement of titanic proportions the magnitude of which is obscured in a mist of facts and figures that fairly stagger the imagination. On the Eighth Avenue line alone more than 6,000,000 cubic yards of earth and rock were excavated, the blasting and digging going on amid the foundations of tall buildings—the work progressing through a complicated network of sewers, waterpipes, gas mains, telephone conduits, and electric cables while the life of the busy metropolis continued without interruption. It cost $12,000,000 a mile to construct the Independent Division, the most recent addition to the system, and its total cost of more than half a billion dollars exceeds that of the Panama Canal.

The New York Subways are composed of three separate divisions: the IRT, the lines formerly operated by the Interborough Rapid Transit Company; the BMT, previously controlled by Brooklyn-Manhattan Transit; and the IND, the former Independent City-Owned System. Their combined trackage of 761 miles would reach from New York to Louisville, Ky., while their total of 249 route miles exceeds the distance between New York and Washington. A railroad of interstate dimensions operating in the conjested confines of a municipality, its many branch lines, its intersecting transfer points, and its multiplatformed combination express and local stations are the despair of the out-of-town visitor.

Since the daily life of a metropolis is regulated by the time clock of its industry, large masses of its people do the same things at the same time. Sudden, sharp fluctuations in the passenger load during an average week day are testimony of the extreme flexibility in the road's operation. On some of the lines routes are changed during certain periods and then changed back again; on others express trains are run in one direction in the morning and in the opposite direction on the same tracks in the afternoon; on various lines at various times trains are added to regular schedules and headways reduced in some cases to 90 seconds.

The character of the service rendered by this unusual railroad is reflected in the general pattern of its layout, all the lines converging toward the business section, some upon the amusement areas, and others upon the shopping districts. Like a giant octopus, it stretches its tentacles through four of the city's five boroughs—Manhattan, Brooklyn,

THROUGH THE TURNSTILE

The fare collectors on the subway are mechanical and take your money in advance. You deposit a nickel, and the descending coin releases a barrier and lets you pass through to the platform. Change booths are maintained at each station, but attendants are not obliged to take anything higher than a $2 bill.

Ewing Galloway Photo

Bronx, and Queens—providing convenient, 24-hour-a-day transportation to rich and poor alike; making neighbors of 7,500,000 people; measuring by a nickel the distances to the far-flung limits of the metropolis; and fusing into a single unit communities separated by rivers and many miles of streets.

Of all the system's 525 stations, Grand Central, on the Interborough Division, is probably one of the busiest and best known. Located in the heart of the city and a focal point of the business traffic flow, it is an excellent example of the efficiency with which the daily human tidal wave is handled and its movement facilitated. Above it is the Grand Central depot, one of Manhattan's two railway terminals; below it is the Interborough's Flushing and Queens Line station; and at its western extremity is the shuttle connection with the Times Square station.

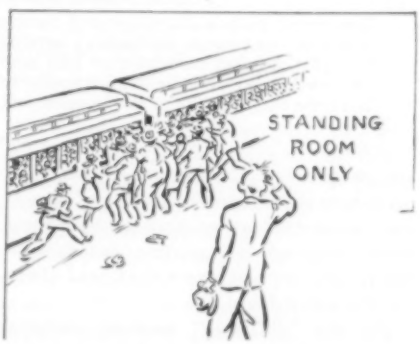
As the morning rush grows in volume, service is stepped up to meet it. Trains pull into the Grand Central Station in a steady procession from the Pelham, White Plains Road, Woodlawn, and Brooklyn branches, literally bulging with their human freight. Thousands disembark and other thousands take their places. Many change from express to local trains, and *vice versa*. Others find their way through long passages to and from the Times Square shuttle, or through the score or more exits to the street, the railroad terminal, and adjacent office buildings. With people hurrying in all directions, the scene rapidly assumes the appearance of a giant ant hill. But in the seeming chaos there is order, the complexities of the station inducing easy, free movement in an otherwise potential bottleneck. Trains enter in steady procession and proceed on their way with little or no delay.

The methods of the subway system are reminiscent of the mass-production technique of industry, and it has efficiently met every demand made upon it, whether a routine peak load or an extraordinary concentration due to some special event. It has handled in its stride crowds whose proportions rival the mendacious ravings of Baron Munchausen, its daily average of 6,500,000 passengers during the latter part of 1944 being equal to the combined populations of the states of Indiana and Minnesota. At this rate, every man, woman, and child in the United States could ride at least once in a single month.

The rolling stock, which totals 6494 cars, would make up a train approximately 71 miles long. Although differing in appearance and design, the cars of the three divisions have several things in common—they are of all-steel construction, have automatic doors, plenty of floor space for "standees," handholds for "straphangers," and a panorama of car cards. The newest type seats 56 persons and, during the so-called rush hours, carries an additional 220 who must perforce stand and try to keep their elbows out of their neighbors' ribs.

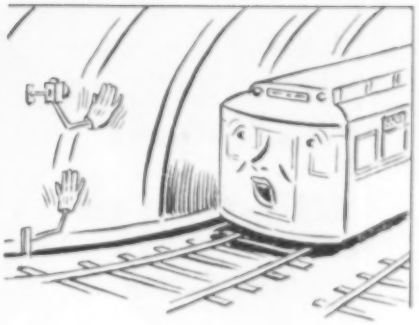
The trains are electrically driven, receiving their motive energy from a "third rail" through the medium of a metal "shoe." The same source supplies current for lighting and heating the cars and for operating the air compressors which, in turn, furnish the power for air brakes and car doors. Three to ten cars make up a train, depending upon the line, the day of the week, or the time of the day. On the IRT and BMT, alternate cars in each complete train are motor cars, each of the latter being followed by a trailer car. On the IND Division every car is a motor car. These operate as a unit, controlled by the motorman from his cab at the head of the train. Trains start smoothly, pick up speed evenly and quickly, and stop just as smoothly and quickly.

An automatic system of block signals



insures the safety of traffic. When one train enters a block, it makes electric contacts which actuate the signals for three blocks behind it. Thus the movement of the following train is controlled and a safe distance maintained between moving trains. A unique feature of the system is a trip device which operates automatically in conjunction with each signal, precluding all possibility of a train passing a red light through either mechanical or human failure. It's an insignificant-looking lever, approximately 10 inches long and located close to the track, that, probably more than anything else, has been responsible for the subways' reputation as the "safest railroad in the world." This remarkable little contrivance rests on the roadbed when the block is clear and raises up when the signal turns red. In this position it contacts a similar trip device projecting downward from the passing car, opening a valve and releasing the air in the brakes. The train is brought to an immediate halt in spite of and independent of its normal methods of control.

An additional safeguard against man-failure is a device known as the "dead



man's button" which is located in the handle of the motorman's throttle. While the train is moving, the motorman grips the control handle with enough pressure to hold down the button. Should anything happen to him and his hand release the pressure, the button automatically turns off the power and sets the brakes. At key points along the right of way, dispatchers sit before lighted indicator boards, telephones at hand, checking headways and schedules. Keen-eyed trackmen patrol dark, underground passageways, watching and searching without cease for trouble. Mechanics, the minutemen of the road, are always on the alert to answer the motorman's call for emergency mechanical assistance.

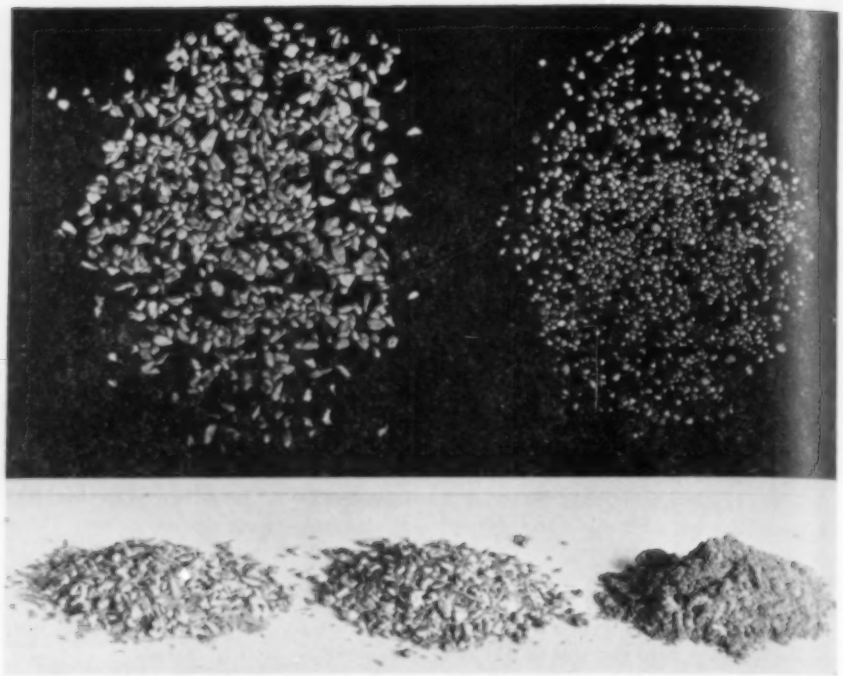
On the New York Subways the average life of a rail at busy points is seven years. Tracks are continually being replaced and repairs made without interrupting service. In the operation, maintenance, and growth of the system, compressed air plays an important part. Brakes, block signals, tripping devices, car doors, and sliding bridges which close the gaps between car doors and platforms at stations located on curves, all contribute to the safety of the passengers and the continuous flow of traffic. Wrenches, drills, riveters, and other air-driven tools for repair work, together with vacuum equipment for cleaning, keep the lines in the "pink of condition" and assure long life and efficiency of the rolling stock. Behind the scenes, in the power plants, air compressors help to furnish the power that makes the wheels go 'round.

More than a billion persons ride the subways of New York City in the course of a year, or in excess of half the population of the entire world. More than a billion persons travel at high speed underneath the surface with even greater assurance of safety than those walking on the sidewalks overhead—a striking testimonial of modern transportation methods and equipment.

A remarkable railroad with a remarkable record taken for granted by the average individual because it is so closely associated with the drab routine of his daily life, but truly a magic carpet performing miracles of transportation in a modern Bagdad.

Soft-Grit Blasting of Metals

E. C. Lathrop
and
S. I. Aronovsky



SOFT-GRIT BLASTING MATERIALS

The upper picture shows ground corncobs before being used (left) and after five hours of continuous air-blasting service. The piles in the lower panel are, left to right: unused corncob-rice hull mixture, the same mixture after use, and dirt and fines removed from the dust collector of the blasting cabinet. It is evident that but little dirt remains in the heap of soft grit in the center.

THE "soft-grit" blasting process for removing hard, thick carbon deposits from cylinders and pistons of aircraft engines undergoing overhaul has become standard practice at many of the United States naval air stations and Army overhaul depots. This method has resulted in considerable savings in man-hours, making it possible to clean from four to ten times as many parts in an 8-hour day as by the older methods. The process is almost foolproof, since properly chosen soft grits do not change the dimensions of the objects, and no masking or hand tools are required. Careless and unskilled operators using the old means of scraping, turning on lathes, and sand-blasting were responsible for the damage to many pistons and parts that sent them to the scrap heap.

By the "soft-grit" method, pistons, cylinders, etc., are first degreased and are then cleaned in a blasting cabinet with corncob or similar grit under 80 to 90 psi. air pressure. The fine dust and dirt are blown to a collector and the grits are recirculated until worked out. Standard sand-blasting equipment has proved entirely satisfactory for handling soft-grit materials, but the naval air stations state that the pressure-blast type is preferred to the induction-blast type.

Early in the war, when soft-grit blasting was being developed, food or feed such as wheat, hominy grits, clover seed, and the like was pressed into service. However, owing to the presence of tetraethyl lead in the carbon, the waste from the process was unsuitable for either feed or fermentation purposes. About that time the Army overhaul depots began to use ground nut shells and cellulose-acetate pellets; but there was a shortage of nut shells, which came mainly from the Pacific Coast, while the plastic pellets were quite expensive.

The Bureau of Aeronautics of the Navy then appealed to the U. S. Department of Agriculture for help in locating a cheap, nonfood, soft-grit blasting material that would be obtainable in large volume. As a result, the Northern Regional Research Laboratory, Peoria, Ill., (one of the laboratories of the Bureau of Agricultural and Industrial Chemistry, Agricultural Research Administration, U. S. Department of Agriculture) began to work directly with the Assembly and Repair Department of the Naval Air Station, Norfolk, Va., and introduced the use of specially ground corncobs and rice hulls. These materials, after considering such factors

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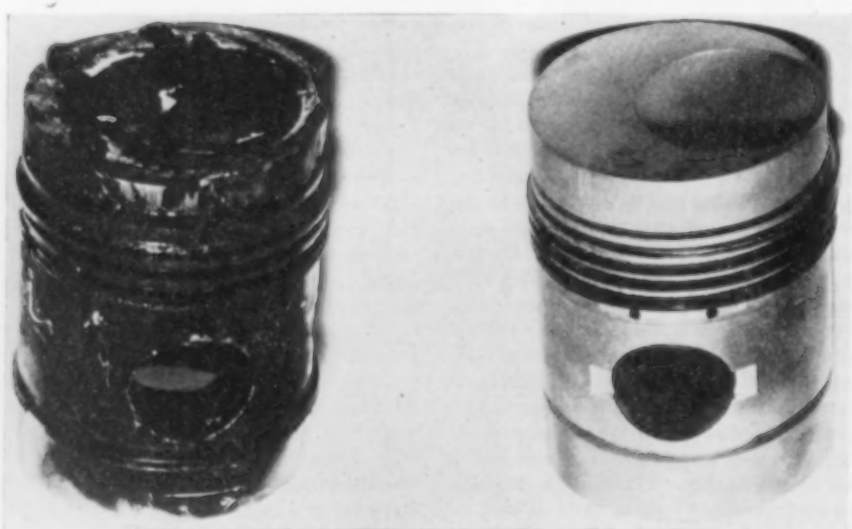


FIGURE 1. DIESEL-ENGINE PISTON

An aluminum piston before and after cleaning with a corncob-rice hull mixture.

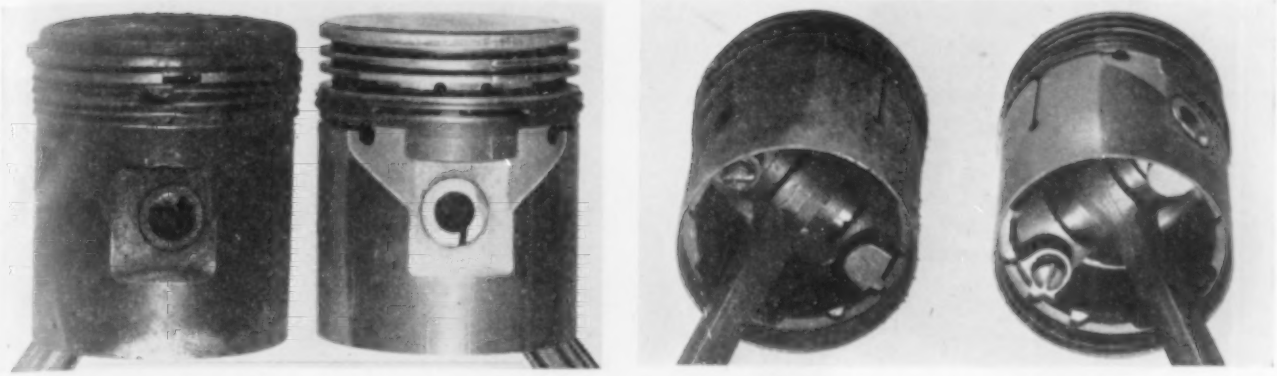


FIGURE 2. OTHER PISTON VIEWS

Before-and-after photographs of aluminum piston-steel connecting rod assemblies showing the thorough cleaning job that was done by soft-grit blasting on both the inside and outside of the parts.

as availability, first cost, total period of usefulness, and operating efficiency, were the most satisfactory ones that had yet been found and were adopted as standard by the Bureau of Aeronautics of the Navy. The specifications call for corncobs ground to pass a 10-mesh screen and to be retained by a 32-mesh screen (Tyler screen series). Chaff and pith particles shall be practically absent. Not more than 13 percent moisture may be present in the cobs.

Corncobs from hybrid seed-corn operations are the most suitable for the purpose because they are dried during the preparation of the seed. They grind best at about 8 to 10 percent moisture content, but are first crushed to pass a ¼-½-inch mesh screen. Then they are ground by an attrition or cutter-type mill to meet the screen specifications. The light pith or beeswing material must be separated from the soft grits by an air blast, and a yield of 50 to 60 percent cob particles of acceptable size may be secured.

Ground corncobs clean airplane cylinders and pistons perfectly, with no change in dimensions and no pitting action. Because of their resilient character, dirt does not collect on the particles. One of our pictures shows the relative size of soft grit of this kind before and after a 5-hour test conducted at the Norfolk Naval Air Base. The particles have shrunk about 50 percent in volume, are free from dirt, and were still doing good work at the end of the test period.

Rice hulls, a waste product of rice mills, may be used directly for blasting. It is not necessary to grind or crack them prior to application because the blasting process breaks them down without difficulty. The hulls contain about 18 percent silica and are slightly abrasive to steel. They do not flow through the air gun so readily as does cob grit and have a much shorter service life. A mixture of about 60 percent corncob particles and 40 percent rice hulls flows easily, has a more rapid cleaning action than corncobs alone, and is now used to some extent by the naval air stations because it has been found to produce no measurable change in dimensions of cleaned parts.

The engineers of the Bureau of Aeronautics have expressed the belief that many uses could be found for the soft-grit blasting process in the metal-fabricating or metal-cleaning industries, as well as in overhaul and repair shops. Using a standard booth loaned by the Navy to the Northern Laboratory, and working with some of the plants in Peoria, a number of the possibilities which exist in these fields have been explored and include the cleaning of automotive, air-compressor, and other machine parts; the removal of paint and finishes from metal surfaces, etc. The results obtained are shown in the accompanying series of pictures numbered 1 to 8, inclusive.

Automotive Parts

Figure 1 illustrates an aluminum piston from a diesel engine before and after it was cleaned with corncob grit and rice hulls, while Figure 2 presents two views

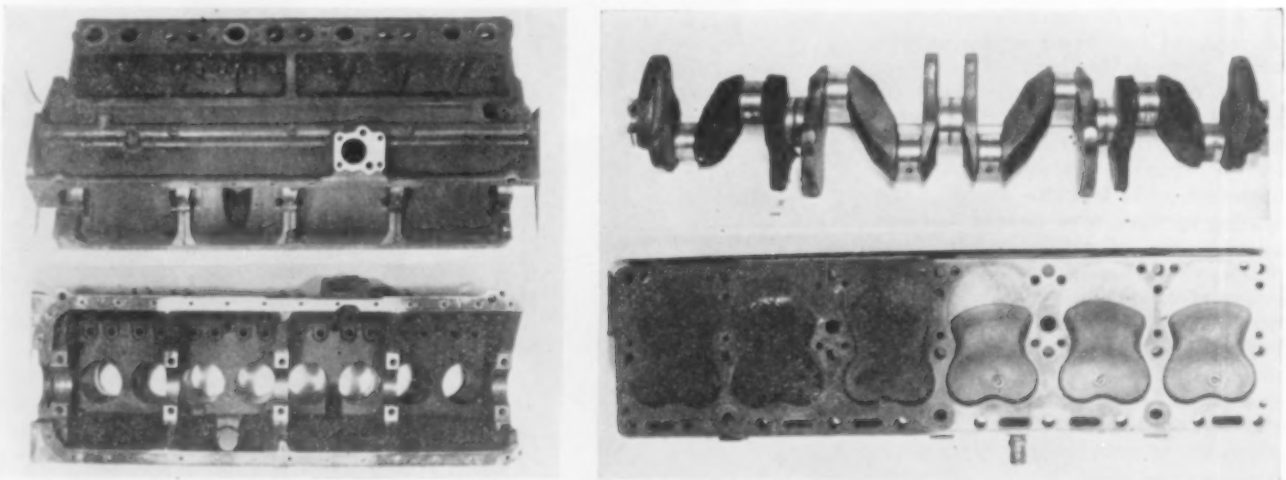


FIGURE 3. ENGINE PARTS

At the left are two views of an engine block whose central section was cleaned for about 25 minutes with a corncob-rice hull mixture. At the upper right is a crankshaft after its midsection had been soft-grit blasted. The material did not pit the bearing surfaces. The head, lower right, has been partially cleaned. Blasting did not affect the electrode gap in the spark plugs, and it was not necessary to reset the points, as is often required after sand-blasting.

FIGURE 4. COMPRESSOR VALVES

Pictured above is an air-compressor valve assembly after part of it had been blasted with a corncob-rice hull mixture for five minutes. At the right are shown valve parts before and after removal of heavy cake of carbon and dirt. Note how thoroughly the grit has cleaned the small holes and the threads.

of aluminum piston-steel connecting rod assemblies which give a good idea of the thoroughness with which soft-grit blasting cleans both the inside and the outside of these parts, as well as the piston rings and the ring grooves.

An engine block from an automobile that had run more than 100,000 miles and that had not been cleaned is shown in Figure 3 with only the central section treated by the soft-grit method. Although the block was heavily encrusted (to a thickness of ¼ to ½ inch in some spots) with grease, carbon, oil, and dirt, the extraneous material was removed very rapidly, leaving a clean metal surface. However, the effectiveness of the corncob-rice hull mixture was reduced considerably by the very large amount of grease and oil on the block. It is therefore recommended that, in cases of excessive accumulations, they be removed by wiping or by solvent action prior to blasting.

The effectiveness of the soft-grit method of cleaning crankshafts is shown at the upper-right in Figure 3. The contrast between the treated center and the untreated ends is quite sharp. The bearing surfaces were cleaned but not pitted by the soft grit. The right-hand bottom view, Figure 3, demonstrates the action of corncob-rice hulls on a cast-iron engine head. Of particular interest in this instance is the fact that the spark plugs in the head were cleaned thoroughly without affecting the setting of the gap between the electrodes. The usual procedure of sand-blasting spark plugs removes some metal, pits the porcelain, and necessitates resetting of the points.

Machine Parts

Soft-grit cleaning of air-compressor parts is illustrated in Figure 4. The right-hand picture shows how effectively the method treats valve parts and bolts heavily caked with carbon and dirt. The compressor valve assembly at the left gives even more striking evidence of the thoroughness of corncob-rice hull blasting. Although not shown well in this photograph, the presence in the cleaned half of the concentric lines made at the time of machining emphasizes the nonabrasiveness of soft grit as applied to metals. Less than five minutes were required to clean the part.

Gears and pinions in final stages of manufacture are pictured in Figure 5. Those on the left are untreated and the others have been exposed to soft-grit blasting. In the case of the right-hand steel pinion at the top, the material not only completely removed the flaked tin with which the pinion was coated but cleaned the inner threads; and from the right-hand gear at the bottom, which was carburized but not hardened, the process readily blasted scale, rust, and carburizing-bath residues. It should be stated at this point that soft grit will not entirely dispose of scale formed in the hardening of steel, in which case it acts as an integral part of the metal surface.

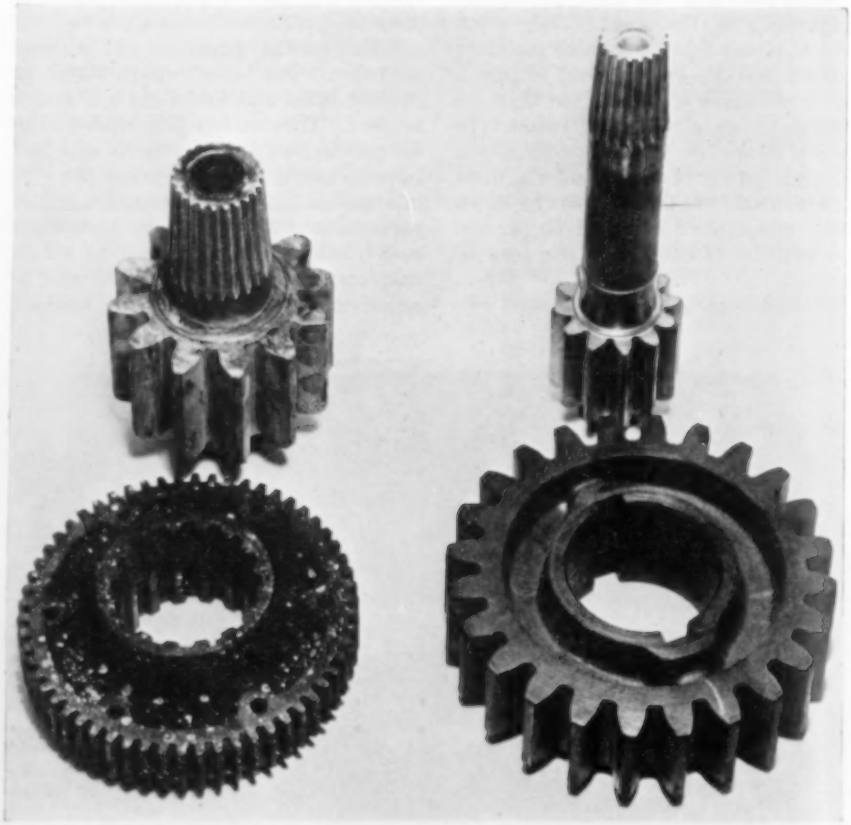


FIGURE 5. MACHINE PARTS

At the left are shown a gear pinion and a gear uncleaned, and, right, similar parts after blasting. The gear pinions at the top had been coated with flaked tin and the gears had been carburized but not hardened and were covered with scale, rust, and carburizing-bath residues.

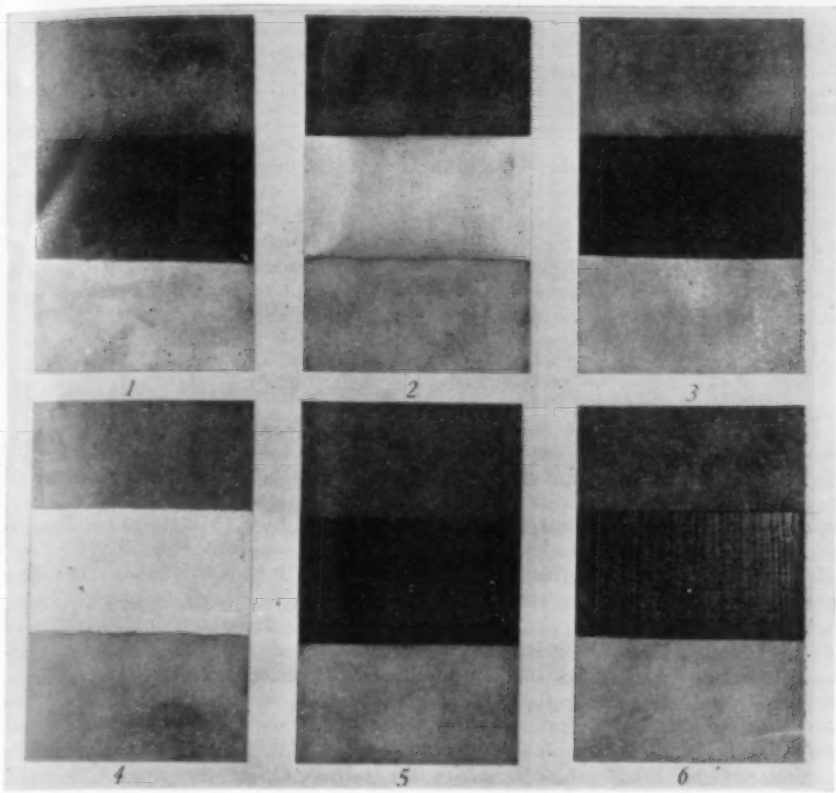


FIGURE 6. TEST PANELS

The topmost part of each panel was cleaned with ground corncobs alone and the bottom with a corncob-rice hull mixture. The central sections were not treated. The panels were coated as follows: 1, with one heavy coat of allyl starch; 2, three coats of aluminum Bakelite varnish baked at 200°F.; 3, three of clear Bakelite varnish; 4, three of leaded zinc paint; 5, three of Army green infrared-resisting pigment and Norelac-nitrocellulose lacquer; 6, three coats of red-barn paint.

Painted and Lacquered Parts

The removal from metal surfaces of paint, varnish, and lacquer, even those with synthetic-resin bases, was easily accomplished by soft-grit blasting. This is well brought out by the panels in Figure 6, the center section of each of which was not treated. The upper part was cleaned with corncobs alone; the lower with a corncob-rice hull mixture.

Miscellaneous

An interesting development in the use of soft grit is that in connection with motor armatures, as illustrated in Figure 7. The iron core and the copper commutator rings were cleaned readily and apparently without affecting the metals. However, it is necessary to mask the wire insulation, which is not resistant to the blasting material.

Rust and welding-scale removal by the process presents no difficulties, but an attempt to remove hard scale from drawn-steel wire so as to eliminate the pickling step prior to coating it with zinc was unsuccessful. This is because the hard scale acts as an integral part of the metal surface, and thus cannot be completely got rid of by soft-grit blasting.

Paint and varnish can be cleaned easily from wood surfaces with corncob-rice hulls. However, this method is not recommended because, in addition to disposing of the paint, the soft grit tends to gouge out the soft spring wood more rapidly than it attacks the harder summer wood. The black and pink surface stains produced when brass is annealed can be removed by means of soft grit, but a frosted finish results.

Commercial Feasibility

It is quite apparent from these results that soft-grit blasting can be applied to advantage in many metal-using industries, in maintenance, repair, and manufacturing. The mechanical superintendents who witnessed the tests at the Northern Laboratory were surprised at the speed and ease of the cleaning process and unanimous in their belief as to its practicability. Those concerned with overhaul and repair of diesel automotive equipment questioned only the cost of the blasting booths and dust collectors for a small shop. They expressed the opinion that the method held great promise not only for engine blocks, heads, pistons, and cylinders but also for many small parts such as spark plugs and for repaint jobs.

Companies in Ohio, Illinois, and Iowa are now equipped to grind corncobs to Navy specifications, and many others have expressed an interest in the business. The price of ground cobs in bulk, f.o.b. mill, is in the neighborhood of $30 a ton. The rice millers in Arkansas, Louisiana, Texas, and California have found little use for the hulls, which should be available in bulk at the mill at approximately a third of the cost of the ground cob grits. Sand in bulk comes to about $10 to $12 per ton. The relative weights of these materials is given in an accompanying table. It

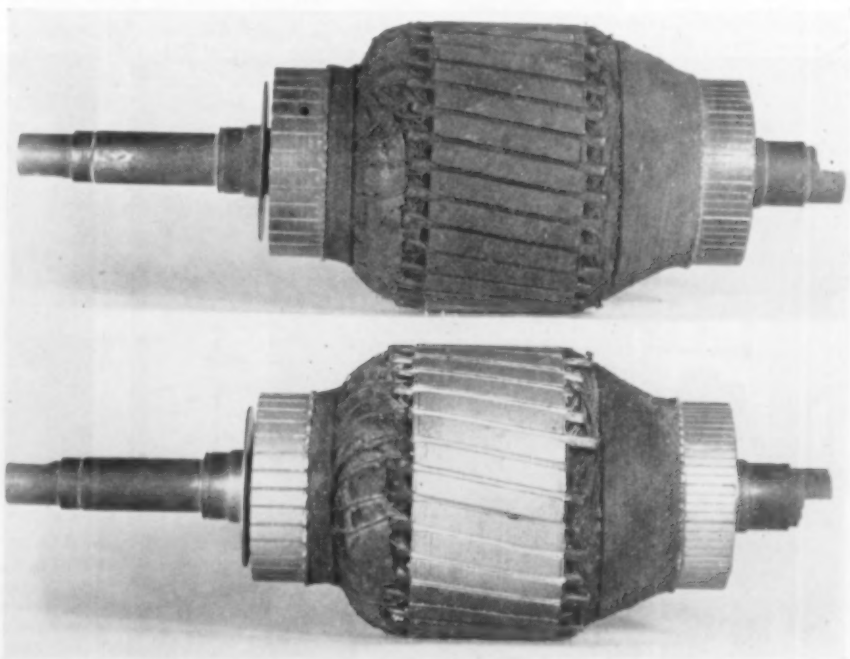


FIGURE 7. MOTOR ARMATURE

Views before and after blast-cleaning with a corncob-rice hull mixture. It is necessary to mask the wire insulation to protect it from damage during blasting.

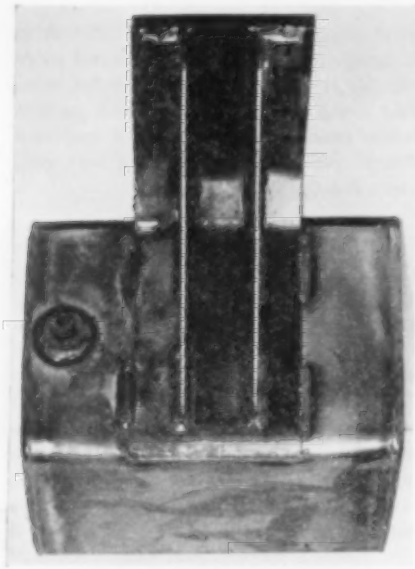


FIGURE 8. GAS TANK

The left part of this auxiliary gasoline tank for a diesel engine was untreated, while the right section was cleaned with a corncob-rice hull mixture. Note the complete removal of welding scale from the right side.

will be seen that the soft grits have about 3.5 times the volume of sand. Sand and rice hulls both have a relatively short life in blasting operations, while corncobs have a very long service life. The cost of these materials in actual use may, however, not differ much.

There are doubtless many purposes for which sand and possibly shot are now employed where soft-grit blasting would do as good a job with greater safety, and there are many others for which neither sand nor shot may be used but for which soft grit is ideal. Soft grits

Blasting Material	Weight per Cubic Foot
Rice hulls, ground	29.6 pounds
Corncobs, ground to Navy specifications	28.4 "
60 percent corncob–40 percent rice hull mixture, ground	28.8 "
Blasting sand	100.0 "

are not recommended for removing mill scale and baked enamel, for smoothing castings, or for other operations requiring high abrasive or cutting action on metals. Except to a small extent, they do not act as polishing agents on hard metals, and they will not burnish. However, they do produce a smooth, nonpitted surface.

Postwar Opportunities

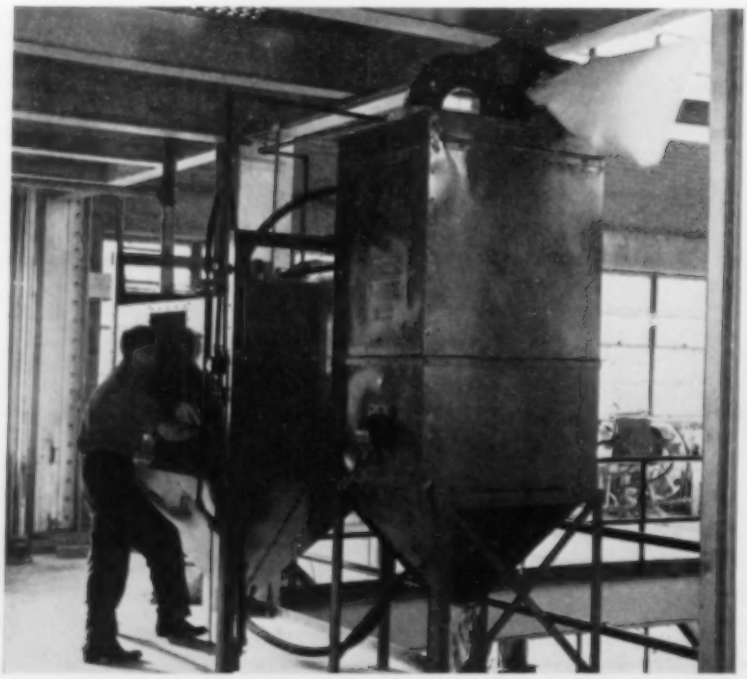
Soft-grit blasting is an established business of small proportions that has started to grow in a number of directions. A prominent manufacturer of blasting equipment has reported that the company is receiving inquiries concerning the availability of soft grits with increasing frequency. The tests have clearly indicated the national applicability of the method. Standard blasting equipment such as is to be found in large industrial establishments can be used, and requires no alterations. For the thousands of automobile, farm-machinery, and other repair shops in every city and village, there is need of simple booths and equipment to make the process attractive. Here is an opportunity for the designing, construction, and merchandizing of low-cost booths, air compressors, air guns, and dust collectors or cyclones.

That is one side of the picture. Another is the small rural businessman who is anxious to process farm wastes into useful products and to obtain more income. Soft-grit blasting gives him a chance to market thousands of tons of corncobs, rice hulls, and other farm wastes annually. And no less important is the opportunity it offers the handicapped service man to begin a modest and perhaps portable cleaning shop in a rural community. In short, the development of this branch of industry, energetically promoted by equipment manufacturers, can provide much new postwar employment.

Acknowledgement

The Northern Laboratory desires to acknowledge the coöperation of R. G. LeTourneau, Inc.; Caterpillar Tractor Company; Keystone Steel & Wire Company; Egolf Motors, Peoria, Ill.; The Bauer Bros. Company, Springfield, Ohio; Sprout, Waldron & Company, Muncy, Pa.; F. S. & W. Cob Products Company, Bloomington, Ill.; Lieut. Commander E. E. Gallahue, USNR., Production Branch, Office of Procurement and Material, Navy Department, Washington, D. C.; Lieut. Cloyd A. Snavely, Engineer Division, Assembly and Repair Department, Naval Air Station, Norfolk, Va.; and of others who have contributed to this development.

Naming of these firms should not be construed as an endorsement of them or their products by the U. S. Department of Agriculture. They are the companies which have aided the Northern Regional Research Laboratory in the work of developing and testing soft grits from agricultural residues.



BLASTING EQUIPMENT

At the left is shown the blasting booth and dust collector used in the experiments described in this article and conducted at the Northern Regional Research Laboratory, Peoria, Ill. The other view pictures the interior of the booth during the cleaning of a metal rod.

This and That

Hell's Gate Fishway Successful

The construction of fishways on the Fraser River at Hell's Gate, in British Columbia (described in our May, 1945, issue), has already had successful results. After having been prevented since 1911 from returning to the upstream spawning grounds of their forebears, sockeye salmon are now able to pass through the gorge. So far this season the sockeye catch on the Fraser has been nearly 50 percent greater than in 1941, the preceding cycle year (sockeye return to spawn after four years in the ocean). It is also reported that shoals of the fish have made their way past Hell's Gate, thus insuring a large catch in 1949. The clearing of obstructions from the river and placing of fishways was started during low water last fall. The program has not been completed, but the salmon are having no difficulty in getting through.

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Steep Rock Iron

In our April, 1943, and April, 1944, issues we described the general aspects of the ambitious program of Steep Rock Iron Mines Limited, Canada, which included the diversion of the Seine River to by-pass Steep Rock Lake and the dewatering of a part of that lake to uncover three ore bodies. The latter work called for the pumping of two million tons of water a day, and it progressed so rapidly that a section of the bed overlying the highest point of one of the deposits was bared August 1 of last year after fourteen large Cameron centrifugal pumps had lowered the water surface some 7 inches a day for more than five months.

The ore body was covered by from 20 to 100 feet of silt and clay, and some of this material had to be removed before mining could begin. Actual ore production was started last spring, and by July 31 nearly 200,000 tons had been shipped. Meanwhile, a dozen or more monitors were loosening more of the overburden and two suction dredges were removing it. That operation is proceeding and gradually working from the center toward the outer limits of the deposit where the covering is thickest.

Up to the middle of August some 5,000,000 cubic yards of overburden had been disposed of, exposing enough of the ore body to permit opening two mining pits about 1200 feet apart. Production of ore has been increased from 2000 tons daily to 4000 tons, and the aim is to bring it to 6000 tons before winter enforces a shutdown until spring. The indicated output for 1945 is 700,000 tons. The rate of production is limited by the speed with which overburden can be removed to enlarge the available mining area. The ultimate objective is an output of 3,000,000 tons a year, which would mean 15,000 tons a day during the 200-day season that weather conditions afford in that latitude.

The first ore shipments went out via railroad to Superior, Mich., and thence by boat to steel plants in the United States. With the completion of half the planned dock facilities at Port Arthur, Canada, it was possible to start transportation from that point also, and the first boatload left there on July 21.

After being drilled and shot, the broken ore is loaded by power shovels into trucks that haul it to a crushing and screening plant, from which it goes into railway cars. Three grades are being produced, and all are classified as Old Range Bessemer which commands the top market price. The best grade, Steep Rock Lump, meets a guaranty of 57.6 percent iron content, less than 0.045 percent phosphorus, and less than 3.5 percent silica. The iron content of the two other grades is 56.4 percent, with phosphorus as just stated and silica around 5 percent.

For several years all operations will be concentrated on the deposit now opened up and known as the "B" Ore Body. The "A" Ore Body will be the next one uncovered, while "C" will be left until some years later. It is estimated that 40 million tons can be recovered from the "B" and "A" ore bodies by open-pit work, after which underground mining will have to be done.

Some 400 men are now employed on the project, but 75 of them are removing overburden, which is being handled at a rate of 400,000 cubic yards monthly. When the deposit has been completely uncovered and mining operations can be carried on more efficiently, it is expected that a force of 200 will suffice.

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English Balloon Barrage

The English balloon barrage, which proved an effective weapon against German aerial attacks and which was described in our May issue, was terminated on February 5 of this year. The first gas bags were flown in the London area in 1937 following the memorable Munich conference. By September, 1939, there were 600 balloons in the air, and at the end of 1940 their number had increased to 2400. When the buzz bombs started coming over late in the war more were floated, and in August of last year there were 2000 of them in a dense belt to the south and east of London alone. They were moored along the Normandy beaches after the invasion, and now it is disclosed that they also guarded the Suez Canal and certain places on the Persian Gulf, in India, and in Ceylon. They were also used in connection with the Sicily and Salerno landings. The English gas industry, which compressed most of the hydrogen with which the balloons were inflated, furnished nearly 2000 million cubic feet of that gas. Since it takes about 300 pounds of high-tensile steel to store and transport 3 pounds of hydrogen, or 600 cubic feet, not much of it could be held in reserve and most of the supply had to be compressed as it was required. Figures made public recently show that the average hydrogen-producing plant with a purification system and a 150,000-cubic-foot holder involves an outlay of around $200,000. The cost of a compressing plant, including buildings, four compressors, and accessory equipment, was approximately $50,000.

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Rabbits and Cyanogas

In our January, 1945, issue, is a brief item on our *This and That* page telling of the use in Western Australia of carbon monoxide from gasogene units for killing rabbits. We were interested not so much in the identity of the lethal gas as the fact that blowers are used to push it into the rabbit warrens through flexible tubing. Quite innocently, we appended a sentence, based on a similar statement in an Australian technical magazine, reading: "These units are enabling farmers for the first time to deal effectively with the rabbit menace." In defense of its product "Cyanogas" (calcium cyanide), the American Cyanamid & Chemical Corporation took exception to the statement and, through its technical representative in Australia, has informed us that "Cyanogas" was introduced into Australia twenty years ago and attained preëminence as a rabbit fumigant in every state of the commonwealth. To quote: "Tens of thousands of blowers have been built in Australia and have applied many thousands of tons of Cyanogas, ounce by ounce, to rabbit warrens." The material is blown into the warrens in the form of dust and then generates a gas. It stays underground for many hours, meanwhile releasing gas, which rises and follows the underground passages and thus eventually fells most of the rabbits that have taken refuge in dead ends. All other fumigants, we are told, are blown underground in gaseous form. They are effective if they contact the rabbits, but if they do not penetrate to the dead ends they are absorbed by the soil and the animals in them come out unharmed.

So the B-29's Could Fly

R. P. Day

BEHIND the excellent work of Army ground crews and pilots of the relentless B-29's is another story—the tale of Seabees who gouged a nest for high-octane aviation gasoline tanks out of the jungle. Sweating, hurrying, and figuring the man-hours of erection on tanks, Seabees helped to fix up the Marianas so the thirsty sky giants could drink, take on bombs, and fly the flak-ridden skies over Japan.

Gasoline tanks holding 10,000 barrels each were set up in groups, and it was no easy job. They were known as tank farms and were mostly located in areas where opposing natural forces prevailed. The raw jungle—coconut trees, vines, brush, and a few heavy hardwood trees covered the mountainsides in unbelievable profusion, and under all that growth lay only about a foot of dull-red topsoil. Beneath that was pure-white coral rock, harder than the men liked to contemplate, but not quite hard enough to make them say "it can't be done." Much of the erection was planned in coöperation with army logistics and air officers by a U. S. Naval Construction unit of which Commodore W. O. Hiltabidle, U.S.N., was the officer in charge.

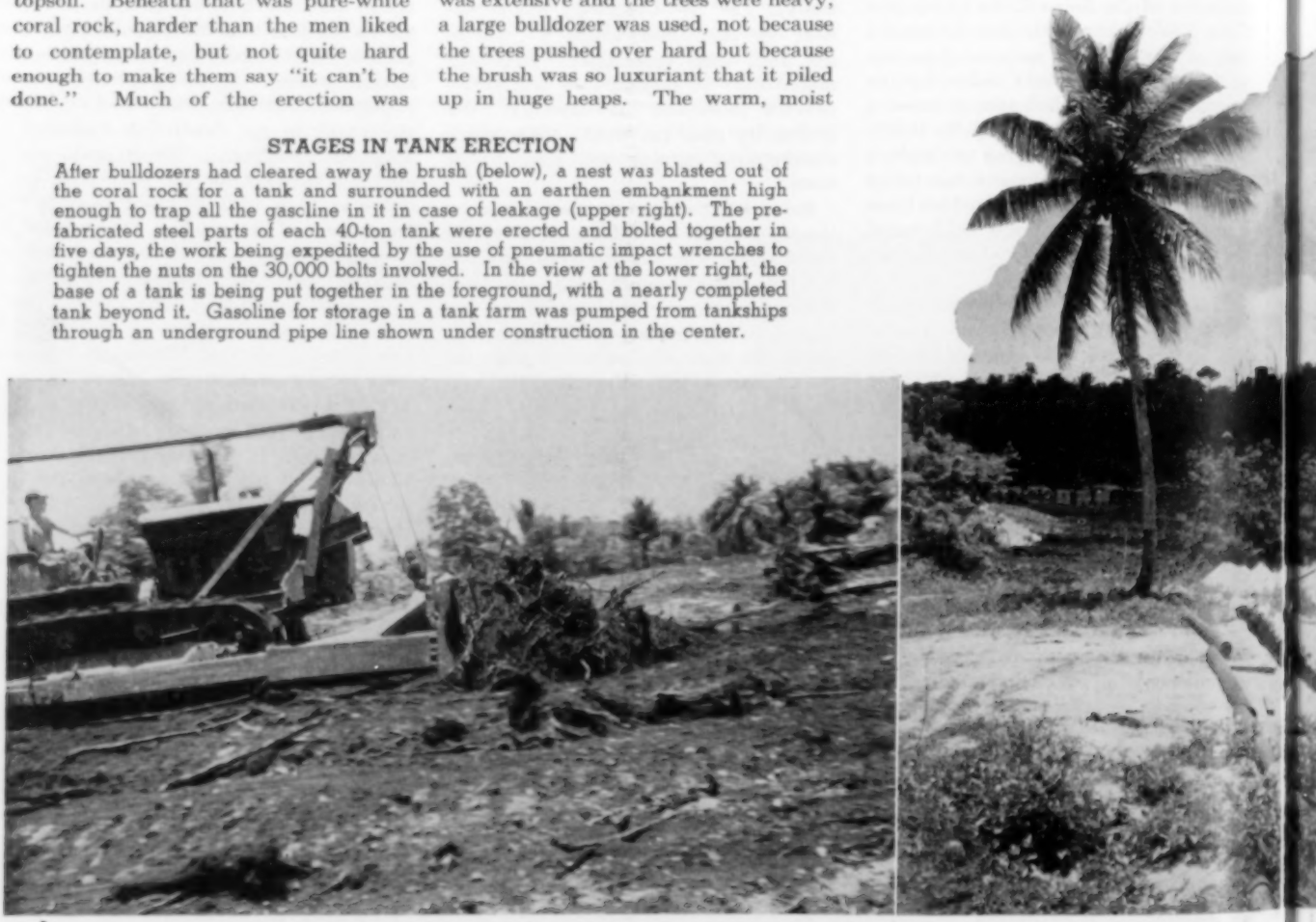
"Ready tanks" at the fields fueled the planes; and in the early stages in the Marianas, work was so rushed that many a tank ship pumped direct to those tanks. That situation was corrected as soon as possible by the building of storage tank farms, which could be filled easily by tankers and which allowed the gasoline to settle before it was used. The fuel could then be transferred to the ready tanks at leisure.

Modern high-test aviation gasoline is dangerous to handle, and all the safeguards against leaks, fire, or bombing must be taken into consideration in the design of a tank farm. In the Marianas, each 10,000-barrel tank was set in a nest blasted out of the hillside, and a heavy earthwork berm, high enough to trap every drop of gasoline in a full tank in case of a leak, was thrown up around it.

Tank-erection specialists from the oil fields of Oklahoma, riggers from Grand Coulee Dam, and dirt movers from Panama and the Pennsylvania Turnpike were in the Seabee ranks. The dirt movers went in with heavy bulldozers, usually mounted on Caterpillar D-8 tractors, to clear away the jungle trees and brush. Where the work involved was extensive and the trees were heavy, a large bulldozer was used, not because the trees pushed over hard but because the brush was so luxuriant that it piled up in huge heaps. The warm, moist tropical climate, helped by termites and natural decay, reduced a big mound of fresh brush into a small heap of mold in a few months.

Bulldozers also scooped nests out of the red, pungent earth. Where it was possible to utilize a ripper and loosen the formation to permit carryalls to work, that was done; but the hillsides of the Marianas are solid coral rock, and the men struck coral long before a shelf 6 feet deep could be gouged out of them. When it got too tough for bulldozers, rippers, and "push cats," the Seabees brought in compressors, wagon drills, and a few Jackhamers and drilled holes to a depth of about a foot below grade on 6-foot centers. Heavy charges of gelatin tore the rock loose in a heap of rubble that the bulldozers could handle. Where dirt had to be moved in to shape the lower half of the berm, tractor-drawn carryalls hauled topsoil from the base of the hills where it could be found in thicker layers.

Tank nests were carefully laid out and checked repeatedly by Seabee surveyors. With the base fine-graded and the berms shaped by a small bulldozer working on top, the Seabees trucked fine coral sand from the seashore and spread a thin cushion of it under each tank. After this layer was dressed until it was nearly as smooth as a dance floor, then every-



STAGES IN TANK ERECTION

After bulldozers had cleared away the brush (below), a nest was blasted out of the coral rock for a tank and surrounded with an earthen embankment high enough to trap all the gasoline in it in case of leakage (upper right). The prefabricated steel parts of each 40-ton tank were erected and bolted together in five days, the work being expedited by the use of pneumatic impact wrenches to tighten the nuts on the 30,000 bolts involved. In the view at the lower right, the base of a tank is being put together in the foreground, with a nearly completed tank beyond it. Gasoline for storage in a tank farm was pumped from tankships through an underground pipe line shown under construction in the center.

thing was ready for the steel erectors.

The actual work of construction on the job where the field notes were gathered for this article was done under the immediate direction of O. E. Stapleton, C.S.F., who was general foreman in charge of rigging for the first five hydroelectric units at Grand Coulee Dam before he joined the Seabees. He preferred a crew of 20 to 24 men on each tank, and he didn't like to spend more than 1200 man-hours in building a unit, complete. When the Seabees started erecting, the prefabricated parts were all on hand and the job had been carefully laid out; but it was still up to the steelmen to handle and place 74 bottom plates, 111 side sheets, and 74 roof sections, as well as to bind them together with 30,000 steel bolts. Altogether, a tank weighs 40 tons. Small air tools speeded up the work considerably. Imagine tightening 30,000 bolts and nuts with a hand wrench! One man with a pneumatic impact wrench could tighten nuts as fast as he could set the socket on them.

The work was hazardous, but the Navy safeguarded its Seabees by using machinery wherever possible to help in steel erection. Truck cranes moved from place to place and set side sheets where needed. The cable slings that were used in hoisting steel were of preformed wire rope because it is easier to handle than the nonpreformed. Furthermore, when fatigue breaks do appear on preformed rope, the crown wires do not wicker out and stab the hands of the workmen who have to handle the slings.

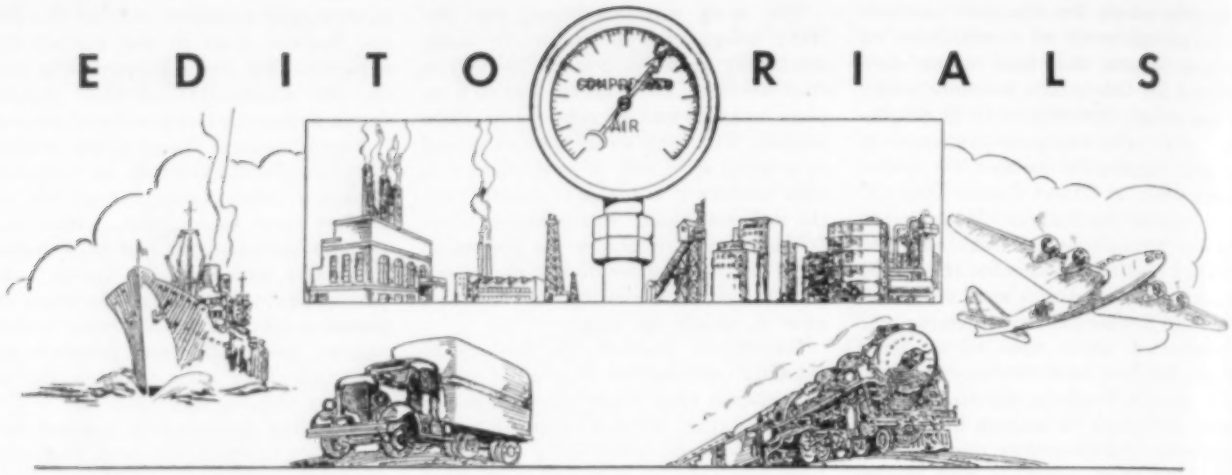
Experience enabled the Seabees to expedite construction to a point where one 24-men crew could erect a tank in five days time, divided as shown below. Dirt work and excavating ordinarily took two days, so each gang accounted for a complete tank in a week. It didn't require many crews afield to increase the storage facilities at an airfield by a quarter million barrels, and the fact that the Seabees went in and pushed disagreeable, hot work accounted in part for the spectacular offensive against Japan during the last months of the war.

Pipe lines from the pumping stations were laid in ditches dug by trenching machines, which excavated all but the hardest coral successfully. After they were in position and had been tested, bulldozers backfilled the trench. By placing the farms strategically where the pumping stations did not have to work against too much head pressure, the elevation differential between the sea and the airfields was overcome.

After the Seabees had finished their job, Navy fuel men took over. They filled the tanks with gasoline and a little water (the water filled the bottom 18 inches and was drained off periodically), and operated the farms from then on.

Laying and bolting bottom steel sections	1.0	day
Erecting side sections	1.5	days
Erecting rafters, purlins, etc.	0.5	day
Erecting top sections	1.0	day
Trimming, tightening bolts, testing tank	1.0	day

EDITORIALS



PUTTING THE LAND TO WORK

A HINT of future wars is contained in the announcement by Hugh H. Bennett, chief of the Soil Conservation Service of the U. S. Department of Agriculture, that "there is no longer an abundance of good productive land to feed and clothe the peoples of the world; in fact there is not a single acre to waste." Such a statement carries a portent of wars to come, because the quest of colonies to meet the demands of overcrowded regions has always been a leading cause of international conflicts.

It is difficult for us in the United States to realize that there is a shortage of land to cultivate. We have been profligate in our treatment of the soil, and men now living can remember when there was plenty of land to be had almost for the asking beyond the frontiers of the West. For that matter there is still a vast acreage between the Mississippi and the Pacific Coast that is capable of supporting millions of persons if it were given just one thing—water. The Bureau of Reclamation has made many arid areas bloom, and it is safe to assume that its program will be greatly enlarged in the future. Climatically, most of this land is preferable to the eastern and southern sections of the country, and it shouldn't be hard to get people to move there.

There has, in fact, been a strong westward migration for twenty years, and the war accelerated it. Even so, there were not enough workmen for the west-coast shipyards and other war plants; hence we witnessed the strange spectacle of Henry Kaiser recruiting men in New York City to fill jobs on the opposite side of the country. Many of those who went to California, Oregon, and Washington during the war will not want to return to their former homes, and this is now in the minds of Kaiser and other west-coast leaders who are seeking to build an industrial empire beyond the Rockies. If they succeed in their plans, even more people will be needed to keep the wheels turning and more land will have to be cultivated to feed them. That will call for more vast irrigation schemes.

Mr. Bennett says that there are 460 million acres of good farmland in this country and admits that it is ample to feed and clothe our present population. However, no one expects the population to remain static. As it rises, soil conservation will grow in importance. Already we have 1400 soil-conservation districts, comprising 763 million acres. Because we were originally so rich in land, we allowed 230 million acres to be devastated through erosion, and it will take years and a concerted program to bring them back to productivity.

As for the rest of the world, the Western Hemisphere is decidedly better off than the densely settled Eastern Hemisphere. South America has huge unexploited natural resources, but it is hardly likely that she will invite the surplus peoples of Europe and Asia to make their homes there. In North America, Canada and Alaska are just on the threshold of development, and their mineral wealth alone should insure prosperous conditions for many years to come. Canada right now appears to be on the verge of one of the greatest mining booms the world has ever seen.

It is apparent that there is not so much a shortage of land in the world as there is maldistribution of population. The situation will probably remain unchanged for a long time, for there is small chance of western nations letting down their immigration barriers, at least until the animosities engendered by the war have cooled off. How, then, will the peoples in overcrowded areas eat?

Perhaps our scientists will answer that. Foodstuffs may come out of the chemical laboratories to supplement those grown on the land. Regardless of that possibility, soil conservation and intensive farming methods such as hydroponics are too essential to be disregarded. Thirty-six countries have already started soil-conservation efforts, and it is of the utmost importance that every nation be taught how to use its land to the best advantage.

ENEMY TECHNOLOGY BARED

ONE of the spoils of war that will accrue to the United Nations is a knowledge of recent advances made by the enemy in various lines of technology. Even if there had been no war, most of these things would have become known to us in the course of time, but the turn of world events served to expedite the process and enabled us to reap the results of enemy research without delay.

Weeks before the German surrender, the first of 200 American technical experts entered the occupied sections of Germany to investigate that nation's outstanding industrial developments. They were sent by the War Production Board and the Foreign Economic Administration. Most of them returned during the past summer, and their reports are now being released for the benefit of concerns and individuals that can make use of the information. The first accounts covered nine subjects ranging from plastics and synthetic rubber to X-rays and air compressors.

One of the interesting revelations thus far made concerns a German supercutting alloy that contains no tungsten, which strategic metal was consequently released for other purposes during the war. The alloy consists essentially of vanadium and titanium carbides bonded with metallic nickel.

Other scientists and industrial specialists are now in Germany to delve deeper into Nazi technology, and reports will likely be issued for some months to come. Meanwhile, it may be taken for granted that similar studies will be made in Japan just as soon as conditions permit. Although the Japanese are generally considered to be imitators and not originators, informed Government persons believe we can learn much from the Nipponese. Dr. R. R. Sayers, director of the Bureau of Mines, goes so far as to say that, had they been given time to exploit the natural resources of the countries they overran and to harness their manpower, they could have been on the road to the world domination that was their aim.

Paint Deposited by Aid of Electrostatics

SAVINGS in paint of from 45 to 60 percent are reported through the introduction of electrostatics to paint spraying by mass-production methods. By the new system, the articles to be coated are passed through an electrostatic field into which the gun is directed. As the particles of paint leave the nozzle, they are electrically charged and are attracted to the articles which are oppositely charged, with the result that there is considerably less loss of paint than there would be under ordinary circumstances. The method is also used to remove tears of excess paint from dipped work, but in that case it operates in reverse; that is, the drops are pulled off toward a charged grid beneath or at the sides of the objects.

The electrostatic equipment consists of wire-electrode assemblies or of grids that are connected with high-voltage circuits and set up powerful electric fields between themselves and the grounded conveyor upon which the articles being coated are suspended and which carries them through the field and into drying ovens. Volt potentials may range from 50,000 to 130,000, and currents from 10 amperes to as low as 200 microamperes may be used for the purpose. The high voltage is obtained from ordinary alternating-current lines by means of rectifiers and a transformer or voltage pack.

Electrostatic spraying may be likened to electroplating in that all the surfaces are coated, except that the deposit has a tendency to be heavier on protruded parts than in recesses. The forces are great enough to cause the spray to reach areas not in line with the nozzle; but rotation of the work, where possible, is of advantage because the paint is distributed more uniformly. The charged spray particles repel one another and smooth out any slight irregularities in the density of the fog that may be caused by improper functioning of the gun.

According to a recent issue of *Industrial Bulletin* published by Arthur D. Little, Inc., "Personnel hazards are small because of the small amperage, reportedly less than one-tenth of that necessary for fatality, but an attempt is made to isolate completely the high voltage from the operators. As in all paint spraying, adequate ventilation is important. Studies of the operations by fire underwriters and others have so far revealed no particular fire hazard when units are correctly installed and operated.

"Electrostatic spraying can be applied to wood, rubber, pottery and bakelite as well as to metal, provided that nonmetallic parts are so shaped that they can be backed with a conducting material. It works best with spray materials that can be readily atomized to small size with low pressures. Liquid latex and most rubber compounds can be used in addition to a wide range of paints, enamels and lacquers. Conventional spray equipment with some modifications is used and is said to operate with 12 to 15 pounds air pressure." During the war, this method of spray coating was applied to such articles as mine housings, navy containers, 5-gallon cans, and food containers for the Quartermaster, while detearing was resorted to in the case of dipping operations on fragmentation bomb parts and cartridge cases.

Air, Water, and Soybeans Foe of Flames

NO AMERICAN war vessel, whether it be a battleship, an airplane carrier, a transport, tanker, or landing barge, puts to sea today, we are told, without a supply of "bean soup" aboard. It's not the edible kind, though its basic ingredient is soybeans, but is used to extinguish flames. Fire at sea, even in peacetime, ranks first among maritime perils, but when fighting ships are heavily laden with combustibles, as they must of necessity be in warfare, fire-control becomes even more imperative.

The "soup," for it really looks like it, is known as Aerofoam and is stored in cans that can be quickly rushed to the scene of a fire. It is applied by a hose equipped with a special nozzle through which fresh or salt water is pumped in the ordinary way. At a point in the water line near the jet is screwed another but smaller and shorter hose the free end of which is put into the can. As the water is forced through the big line it creates sufficient suction to feed the fire extinguisher to the nozzle and, at the same time, to draw in air through a special apparatus.

The "soup," water, and air combine to form a heavy snowlike chemical that blankets or smothers the flames by separating them from the fuel they feed upon, sealing in the gases, and excluding oxygen. The stuff flows freely but sticks to surfaces that would shed water, clinging so tenaciously that nothing short of a hurricane, it is claimed, will blow it off. This is of considerable value at sea and at airfields that are always free to the four winds. Its effectiveness is emphasized in the case of the *Enterprise*, an airplane carrier, that was hit by a Jap bomb in the Marshall Islands raid. The missile set her flight and hangar decks aflame, and high-test gasoline was soon blazing fiercely. The ship's fire-fighting crews extinguished the flames, according to reports, in just one minute from the time they went into action with the new chemical.

National Foam System

NOT A SNOW SCENE

The white creamy mass on the shed and ground is Aerofoam, a fire-fighting chemical made by mixing air, water, and a liquid obtained from soybeans. It flows freely and yet clings tenaciously, forming a blanket that smothers the toughest fire. A layer from 6 to 8 inches thick is said to be so impervious to flames that a blowtorch passed over it will not ignite highly combustible materials beneath it. Some of the nozzles now in use on shipboard can deliver 4500 gallons a minute and throw the foam 150 feet.

Photo Tennessee Eastman Corp.

BLUEPRINT STORAGE BIN

Compactness and orderliness characterize this method of filing blueprints at the Buffalo, N. Y., Curtiss-Wright airplane plant. Each is housed in a transparent cylinder which keeps it free from dust and prevents it from becoming frayed and torn in storage. The tubing is made of Tenite, a cellulose-acetate product that is converted into cylinders of several diameters by the extrusion process, cut to the required length, sealed at one end, and plugged with a wooden stopper which bears an identifying label.

Industrial Notes

To give welders relief from heat and obnoxious fumes, a new air-fed helmet has been designed by a group of doctors and safety engineers. It was originally conceived by the Pullman Standard Car Manufacturing Company in coöperation with the Northwestern University Medical School, and further developed by the Chicago Eye Shield Company, which is offering it under the name of Cesco Air-flow Welding Helmet. Clean air is admitted to the hood through a tube that encircles the lens holder and that is perforated, permitting air to flow in all directions along the shell to the outer edges. Contaminated air is thus

prevented from entering, and the operator is able to work in comfort under all conditions. Air at a maximum pressure of 25 pounds is used, and is reduced by the welder to suit his requirements. In addition to the air-control valve, the helmet is equipped with an air-relief valve. There are five different models, each of which has an adjustable headband. For the conversion of standard round-front hoods, the company has an air-supply unit that is ready for installation.

For refrigerating units involving the use of a compressor, Kramer-Trenton Company has developed a defrostor that functions automatically at definite intervals. It is known as Thermobank and is suitable for small as well as large tonnage outputs. The unit is arranged for wall mounting and is essentially a heat exchanger consisting of an inner cylindrical tank disposed vertically in a hermetically sealed outer tank containing a noncorrosive, organic, antifreeze solution, all encased in a steel housing. A heating coil is submerged in the solution and is connected in the refrigerating system between the discharge or hot-gas end of the compressor and the condenser inlet. During normal operation, the hot gases give up some of their heat in going through the Thermobank on their way to the condenser, and this heat is stored in the antifreeze solution until a timer causes the Thermobank to act in reverse, to give up heat to defrost the evaporator coil. In moving through the latter, the hot gas condenses and flows back toward the compressor in that form. However, before the liquid reaches the intake end of the latter machine it passes through the inner tank of the defroster where the stored heat again converts it into gas.

In a recent bulletin issued by the Cincinnati Tool Company is described an attachment that is fastened to the frame of its standard file cleaner and is designed for removing soft-metal chips from files. It's a square plate or plow of steel that is sufficiently soft to take an impression of the tooth pattern. This is done by striking the file with one edge of the plate. The latter is then pushed parallel to the grooves and plows out the embedded chips of lead, copper, aluminum, and the like. When a file of different tooth-spacing is to be cleaned, the impression is made on a new edge. The plates are said to have a long service life and may be replaced at low cost when worn.

American Chain & Cable Company has developed a method of splicing slings of preformed wire rope that is said to make hand - tuck splicing obsolete and to do a better job. According to the manufacturer, its Loc Safety Splice is neater and more compact, is flexible clear to the terminal, retains 100 percent of the rope's strength, does not distort the rope structure, and applies the load stress in direct line with the pull. In addition, it has no seizings to loosen and no wire ends to tear workmen's hands, is always wide open for inspection, and may be used with any standard fitting—

hook, ring, shackle, thimble, etc.—which can be salvaged for further service when sling becomes useless. At the present time the work of splicing is done only at the company's factory.

For testing pressure cylinders, the Narragansett Machine Company has developed what it calls a Hydro-Tester—a steel housing that has the outward appearance of a household refrigerator except for a window in the front through which the work is positioned. Pressure is built up by introducing water at city pressure into each cylinder, which is held between two sealing heads or plates, and then by displacing the water by air pressure applied through the medium of a piston. The latter moves upward through the bottom head under the im-

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pulse of compressed air taken from a shop line, the pressure depending upon the size of the cylinder and working requirements. Motor drive serves to place and to retract the plates so as to clamp and to release the cylinder. Units up to 5 inches in diameter and having a maximum length of 16 inches call for a 36x36x84-inch machine. The company is prepared to build Hydro-Testers to specifications.

It's a far cry from pots and pans to oil paintings, but we are informed that aluminum, of which those household articles are made, may be used by artists as a substitute for canvas. In sheet form, ⅛-inch thick, and treated to give it a minutely porous skin surface of aluminum oxide, the metal is said to be a suitable base for oils. Besides being permanent, the material does not have to be stretched over a frame like canvas, and will not split, tear, or wrinkle.

For the small shop or occasional user of a spray booth, there is now available an infrared oven to bake articles that are not carried along by a conveyor, as they normally are in large establishments. It may be suspended from a crane or counterbalance and is in the shape of a tub made up of one or more stories or rings, each 11 inches high, of standard Miskella units. The oven is manufactured by Infra-Red Engineers & Designers.

For stock-room use and for machine operators, Larrimore Sales Company, St. Louis, Mo., has developed a color code for twist drills and shanks and is prepared to supply corresponding liquid colors. The code is printed on an 18½x 24-inch wall chart and facilitates sorting, issue, and selection of the tools, especially where a number of them of different sizes are required in succession. The list price is $1.00.

Water is an essential component in a concrete mix and should not be allowed to escape during the hardening period. For that reason it is common practice in building roads, airplane runways, and the like to resort to curing methods to prevent evaporation, but contractors generally overlook the fact that the subgrade of pervious material may serve as a drain. This seepage can be checked, it is claimed, by insulating the concrete from the base by moistureproof paper made for the purpose by the Union Bag & Paper Corporation. The material is known as Scutan and is available in rolls up to 12 feet wide for both subsurface and surface use. Many miles of paving have been poured on top of it and more than 1,000,000 square feet was utilized in constructing the runways of the Floyd Bennett Airport in New York City.

WOULD MORE PRECISE TEMPERATURE CONTROL OF LIQUIDS OR GASES

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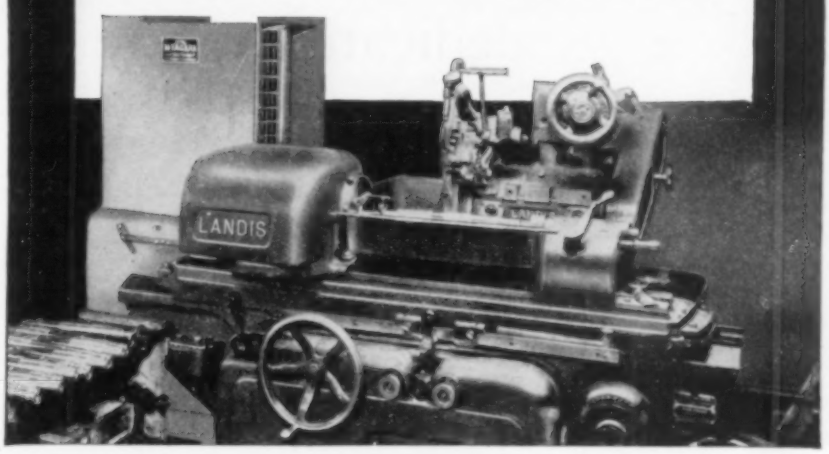

The NIAGARA AERO HEAT EXCHANGER holds the temperature of a liquid or gas within close limits. Many units have been installed because they provide a less expensive and less troublesome way of cooling fluids in an industrial process. But, after installation, users have discovered additional benefits of extra plant capacity, increased production and better quality production because the NIAGARA AERO HEAT EXCHANGER provided accuracy of temperature control.

Cooling of cutting oils, lubricants, quenching baths, engine jacket water; chemicals and intermediates; electronic sets; condensing gases, steam and refrigerants; controlled atmosphere processes; compressed air after-cooling—are processes in which these *extra* benefits are obtained.

For further information, write for Niagara Bulletins 90, 94 and 96, or ask about experience in your own field.

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remaining before us, that from
these honored dead we take
increased devotion to that
cause for which they gave the
last full measure of devotion
that we here highly resolve
that these dead shall not have
died in vain . . ."

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C. M. EASON, INDUSTRIAL CLUTCH CO.
Waukesha Wisconsin

Rubber "coal shovel" — a ton a minute!

A typical example of B. F. Goodrich development in rubber

MANPOWER and coal were two of the most critical commodities during this year's bitter winter. An equipment manufacturer developed a machine that would save manpower by handling coal easier and faster. Called a Hercules power chute, it would unload coal on a conveyor belt 8 inches wide at the rate of a *ton a minute*. It was light weight—could be handled by one man. It could *hurl* the coal into the basement—keep it from piling up at the window. It could pour coal through a window more than six feet high—a 28-degree grade.

But the ton-a-minute rate called for extra high belt speed—so fast that a smooth-surfaced belt would slip beneath the coal, let it pile up and spill to the ground. On an incline, even at lower speed, the coal would slide down the belt and over the sides of the chute.

The manufacturer asked B. F. Goodrich engineers for help. They had already developed a belt called "Grip-top" for handling cartons and bags. Its grip came from thousands of tiny rubber "fingers" on the belt's surface. The engineers studied the coal conveyor—then submitted a sample belt with a new surface design that would grip large and small lumps of coal firmly. Tests were run and coal started moving—fast. Today hundreds of these rubber "coal shovels" are moving thousands of tons of coal each day—quickly and cleanly; saving time, money, manpower.

Whether it's conveyor belt or transmission belt; tank lining or sandblast hose; gasket or rubber printing plate—no B. F. Goodrich product is ever accepted as "standard" by B. F. Goodrich development men as long as there is a chance for improvement through further research. *The B.F.Goodrich Company, Industrial Products Division, Akron, Ohio.*

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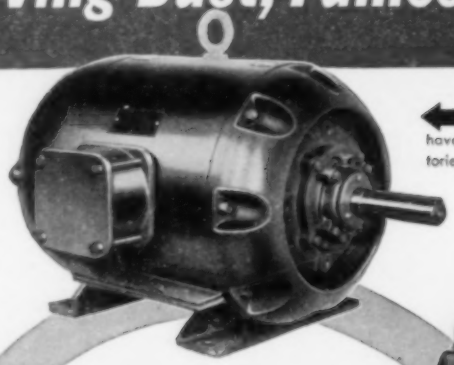
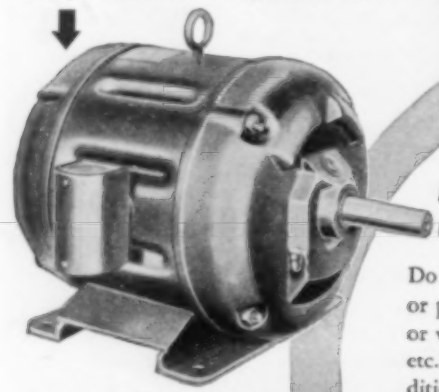
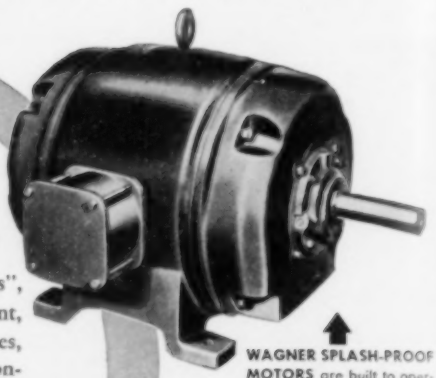
WAGNER DRIPPROOF MOTORS are so designed and constructed that drops of liquid or solid particles falling on the motor at any angle not greater than 15 degrees from the vertical cannot enter the motor either directly or by striking and running on a horizontal or inwardly inclined surface.



WAGNER EXPLOSION-PROOF MOTORS have been approved by the Underwriters Laboratories for Class I Group D hazardous locations, "where gasoline, petroleum, naphtha, alcohols, acetone, lacquer solvent vapors, or natural gas are manufactured, used or handled."



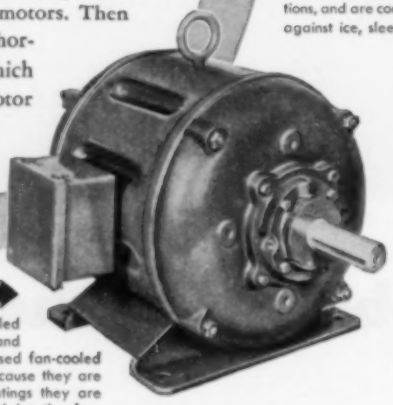


These motors are protected to do their jobs under severe operating conditions

Do you use motors "in hazardous locations", or perhaps where splashing liquids are present, or where the air contains dust, dirt, acid fumes, etc.? No matter how severe the operating conditions, Wagner has the right motor that is adequately protected against such hazards. Check the advantages gained from using these five types of protected Wagner motors. Then let a Wagner motor authority help you decide which type will solve your motor problem.

WAGNER SPLASH-PROOF MOTORS are built to operate dependably in locations where they are subject to splashing water, oil, or other liquids. They are widely used in exposed outdoor locations, and are completely self-protected against ice, sleet, snow, and rain.

WAGNER TOTALLY-ENCLOSED FAN-COOLED MOTORS are designed to operate under severe and adverse conditions in locations where dust, dirt, abrasives, steel chips, filings, acid fumes, and other harmful elements may damage the windings and bearings.



WAGNER TOTALLY-ENCLOSED NON-VENTILATED MOTORS may be installed in the locations just described and are built instead of totally-enclosed fan-cooled motors in the smaller ratings because they are less expensive. In the larger ratings they are used where the draft produced by the fan-cooled motor is objectionable.

Write for Bulletin MU-185 or consult the nearest Wagner Branch . . .

ATLANTA 3 • BALTIMORE 18 • BOSTON 15 • BUFFALO 8 • CHICAGO 16 • CINCINNATI 10
CLEVELAND 15 • DALLAS 1 • DENVER 2 • DETROIT 2 • HOUSTON 2 • INDIANAPOLIS 4 • KANSAS CITY 8 • LOS ANGELES 15 • MEMPHIS 3 • MILWAUKEE 2 • MINNEAPOLIS 4 • NEW YORK 7
OMAHA 2 • PHILADELPHIA 8 • PITTSBURGH 13 • PORTLAND 9 • ST. LOUIS 3 • SALT LAKE CITY 1
SAN FRANCISCO 3 • SEATTLE 4 • SYRACUSE 2 • TULSA 3 • WASHINGTON 5

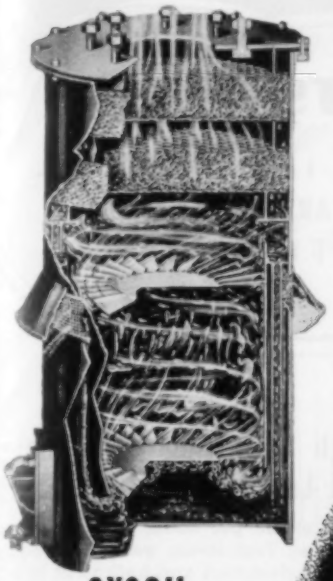
MOTORS are but one of several WAGNER PRODUCTS serving industry.

Other WAGNER PRODUCTS:
AIR BRAKES
•
BRAKE LINING
•
HYDRAULIC BRAKES
•
INDUSTRIAL BRAKES
•
INDUSTRIAL BRAKE CONTROLS
•
NoRoL
•
TACHOGRAPH
(Recording Speedometer)
•
TRANSFORMERS

M45-16

Wagner Electric Corporation

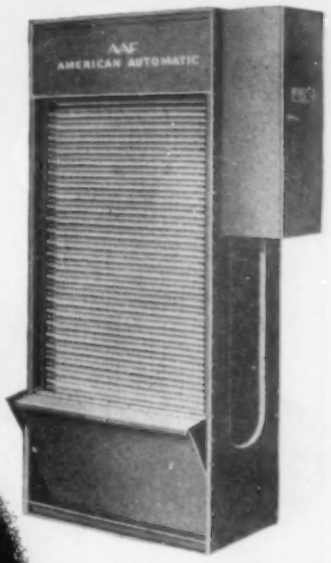
ESTABLISHED 1891
6418 Plymouth Avenue, St. Louis 14, Mo., U. S. A.
In Canada: Wagner Electric at Leaside, Ontario
ELECTRICAL AND AUTOMOTIVE PRODUCTS



CYCOIL OIL BATH AIRCLEANER

For engines and compressors subject to extremely heavy dust concentrations. Principle of operation provides four way cleaning — 1. impingement, 2. scrubbing, 3. cyclonic action, 4. filtering, thus assuring continued self-cleaning action and large dust-holding capacity. Acts as effective intake silencer as well. Write for Bulletin 130-D.

For multiple engine or compressor hook ups, multi-cylinder, and four-cycle and two-cycle engines scavenged by rotary blowers the Automatic filter is especially suitable. Practical for air volumes of 5,000 cfm or more. For detailed information on its operation and self-cleaning principle write for Bulletin 241 A.

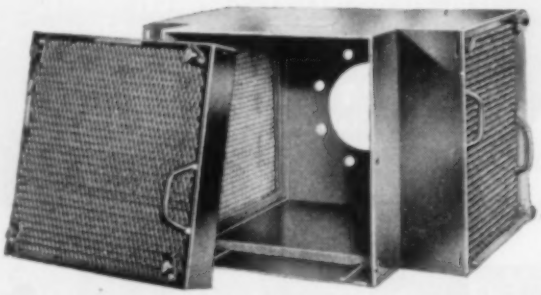


SELF-CLEANING AIR FILTER

AAF AIR CLEANER PROTECTION *Means* LONGER LIFE AND LESS REPAIR COST

Composed of complete assemblies of individual viscous impingement type cells and housings which bolt directly to flange on air intake pipe. Installed outside or inside the buildings. Sturdily built for long years of service. Recommended particularly for use in industrial districts involving normal dust concentrations. Write for Bulletin 120 D.

TYPE "OC-H" FILTER



A dry type filter employing wool felt as a filter medium. Recommended specifically for air compressors of the non-lubricated cylinder type and for engines and compressors where the intake air contains large quantities of lint, flour or other types of dust which do not suit viscous impingement type filters. Come as complete assemblies for installing on air intake pipes. Send for Bulletin 120 D.

TYPE "PL-H" FILTER

SPEED VICTORY BUY MORE BONDS

Preventive maintenance in the form of correctly engineered air intake cleaners pays big dividends. Power plants are too precious and important today to risk unnecessary shut downs and engine or compressor repairs. AAF's 23 years experience in the field of power equipment dust control is represented by a complete line of air cleaners and filters for every dust condition. Send for free engineering data and bulletins describing their installation and operation.

AMERICAN AIR FILTER CO., INC., 402 Central Ave., Louisville, Ky.
In Canada: Darling Bros., Ltd., Montreal, P. Q.

AMERICAN AIR FILTERS AAF

for Engine and Compressor Protection

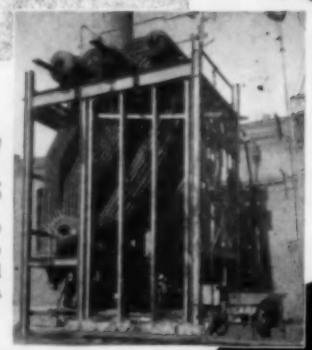
Vogt

PRODUCTS ARE

★ DESIGNED to RAISE
★ OPERATING STANDARDS and
★ LOWER YOUR COSTS

Drop Forged for Safety and Economy under the Most Trying Conditions

Valves, Fittings and Flanges by Vogt—the choice of operating men everywhere for safe and sure regulation of the high pressure and high temperature liquids and gases used in modern process work.



High Operating Efficiencies and Low Maintenance Costs

More steam per dollar of investment—because Vogt steam generating equipment is designed and built to fit in with specific operating conditions. Vogt boilers are available in bent tube types and straight tube, forged steel sectional header types for solid, liquid, or gaseous fuels, as desired. Three-drum types can be supplied to fit any conditions of restricted installation space.

Meeting the Demands for Operating Security

Vogt has every facility for the fabrication of stills, towers, continuous rotary filters, filter presses, oil chilling machines, heat exchangers, etc., and these products are serving the petroleum industry around the world.

Vogt PRODUCTS

For Oil Refineries, Chemical Plants, Power Plants and Related Industries

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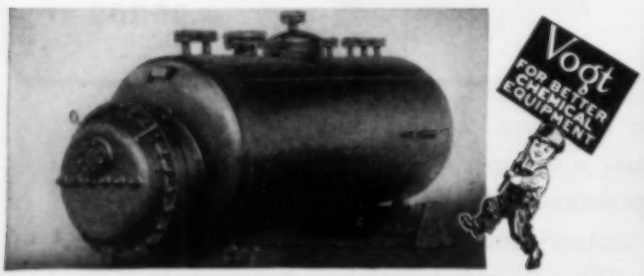

To Combat Corrosion and Product Contamination

Process equipment made from special metals and alloys for the exacting service of the chemical plant is fabricated in our modern shops for many of the well known chemical companies.

Steps Tonnage Up and Costs Down

Our experience of more than 50 years in building profit-making ice and refrigerating machinery is at your command. We make complete units for ice and cold storage plants, packing plants, dairies, breweries, chemical plants, oil refineries, etc.

Is your ROPE-RIGGED EQUIPMENT *ready.. for the big job ahead?*

NO TIME LIKE NOW to check over your equipment's readiness . . . for the big competitive job ahead. And in checking your wire rope, include these points:

Are sheaves and drums regularly checked for excessive wear that would injure the rope operating over them? Does the rope get proper handling, lubrication, inspection, maintenance? Is it Roebling "Blue Center" Steel Wire Rope?

If the answers are "yes", bank on dependable, long-lasting, economical rope service . . . for today's toughest, tomorrow's biggest jobs. For "Blue Center", preformed or non-preformed, combines smooth-running flexibility with high abrasion-and-fatigue resistance . . . and extra strength for extra duty!

It's the result of fine Roebling steel, exceptional equipment, a century-old tradition of sound workmanship. And whether *your* rope problem is one of selection, operation or maintenance, Roebling engineering service can help you solve it . . . to your advantage.

When government needs taper off, Roebling wire rope will again be available to non-priority users, in order of request. Why not place *your* order now?

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TRENTON 2, NEW JERSEY
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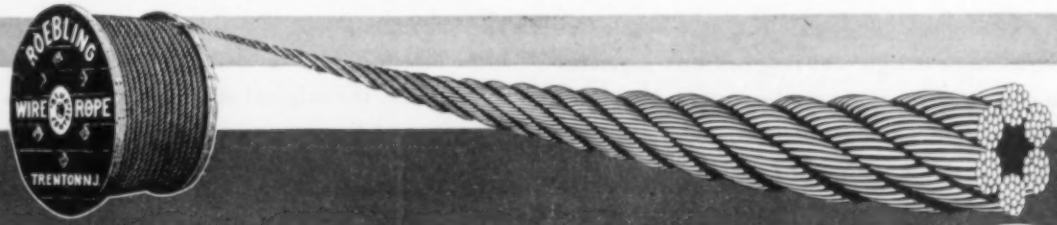
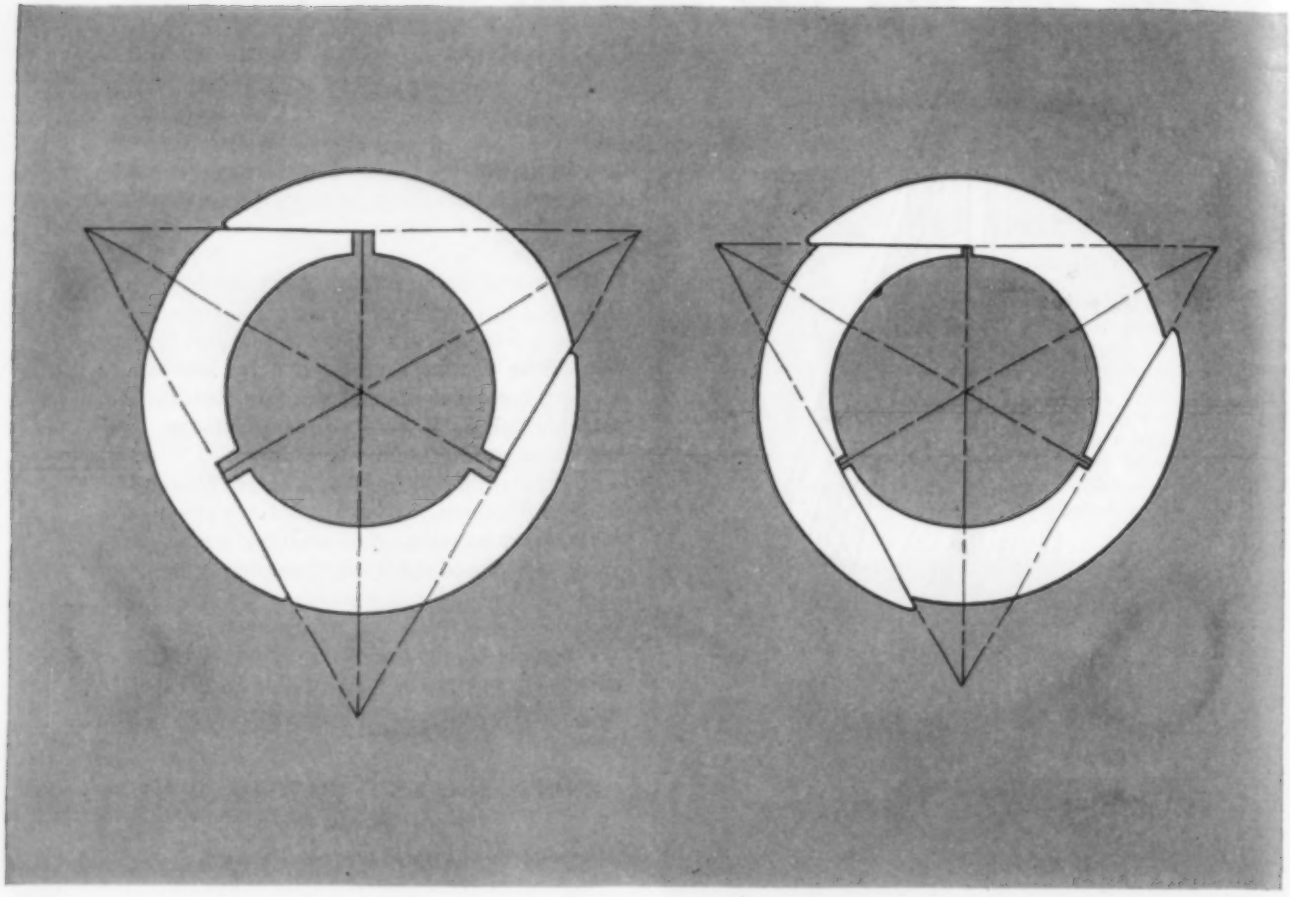
WIRE ROPE AND STRAND • FITTINGS • SLINGS • AIRCORD, SWAGED TERMINALS AND ASSEMBLIES • COLD ROLLED STRIP • ROUND AND SHAPED WIRE • WIRE CLOTH AND NETTING • HIGH AND LOW CARBON ACID AND BASIC OPEN HEARTH STEELS SUSPENSION BRIDGES AND CABLES • ELECTRICAL WIRES AND CABLES • AERIAL WIRE ROPE SYSTEMS



ROEBLING

PACEMAKER IN WIRE PRODUCTS

THE WORLD'S MOST-COPIED PACKING RING



EVERY once in a blue moon a product comes along so good from the start that it's hard to improve upon. Such is the record of the France packing ring—copied and imitated over and over again but never bettered.

Secret of success of the France ring is a simple, ingenious geometric design. The ring has three segments lying in close contact along the lines of an imaginary equilateral triangle. The sides of the triangle lie parallel to, but outward from, a tangent to the bore at the bisectors of the triangle. These same bisectors *divide equally* a space between the stepped ends of the segments.

Unlike other ordinary ring designs, in the France ring relative position of the segments with respect to the sides and bisectors of the triangle is not disturbed as the segments each move simultaneously an equal distance toward the center of the rod to compensate for wear. The space simply becomes less until it becomes zero at the bisector.

Therefore, the original sealing characteristics of the ring remains the same as no change in the geometric design occurs in compensating for wear. The principle is so simple, the design so effective, time has suggested no change that is better.

France Packing sets the Standards for the Industry

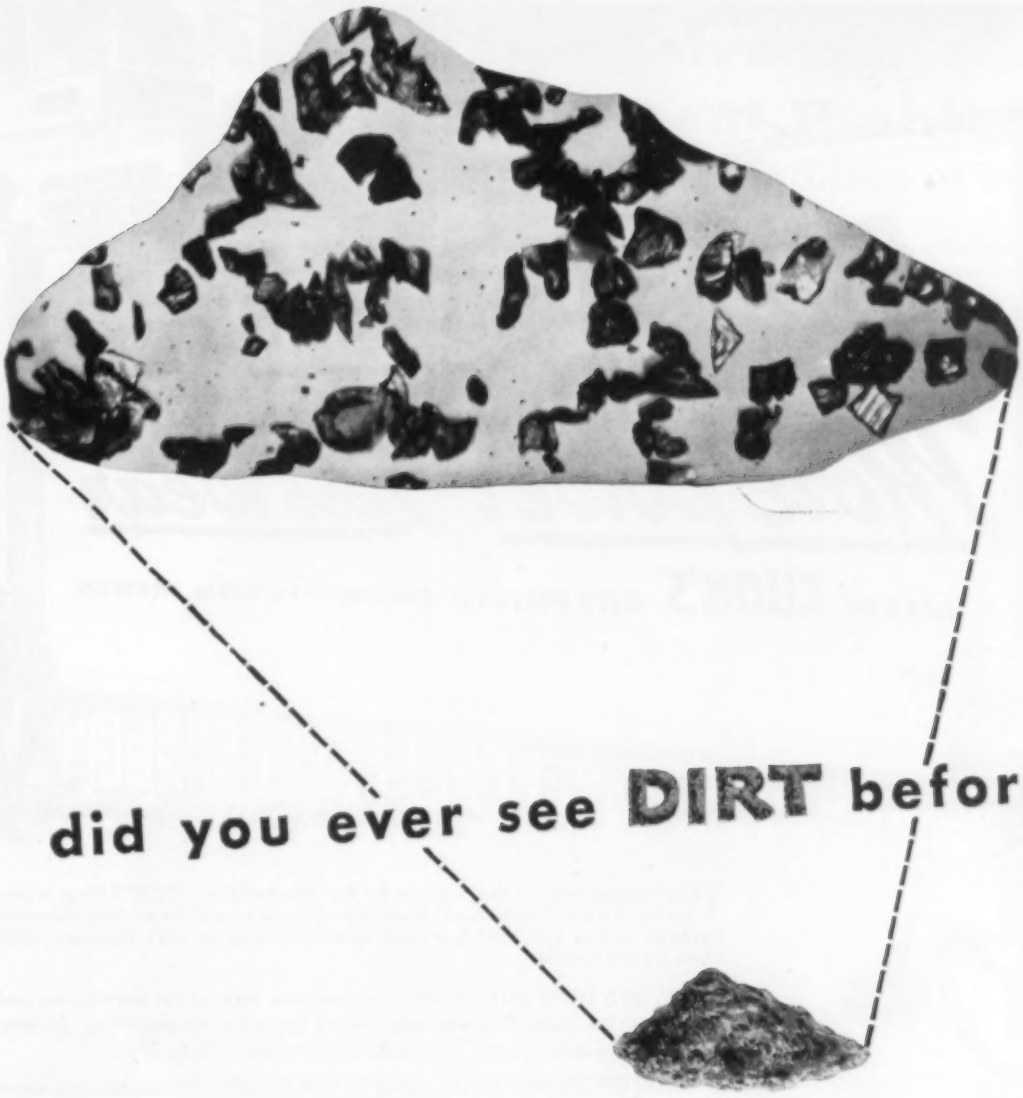
★ FRANCE PACKINGS and PISTON RINGS ★

FRANCE MFG. CO.

FRANCE MANUFACTURING COMPANY

E. A. France, President

Belgrade and Orthodox Streets, Philadelphia 37, Pa.



did you ever see DIRT before?

THIS is what it looks like, magnified 100 times. Sharp flint-like, often germ-laden.

Unfortunately, your products, machinery, merchandise or even customers and workers find dirt harmful—and without the help of a microscope.

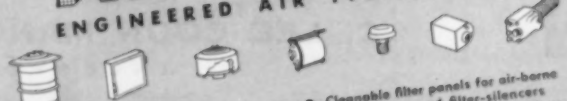
Wherever people, machinery, materials and processes are exposed to air, they are subject to the effects of air-borne dirt—infection, abrasion, contamination and the like.

Separating dirt from air is the job on which Air-Maze has specialized for nearly 20 years. Take advantage of this experience. Send your problems to us, or consult the yellow pages of your telephone directory for your nearest Air-Maze representative. Air-Maze Corporation, Cleveland 5, Ohio. *Representatives in principal cities. In Canada: Williams & Wilson, Ltd., Montreal, Quebec, Toronto, Windsor; Fleck Bros., Ltd., Vancouver, B. C.*

IF IT USES AIR . . . USE

AIR-MAZE

ENGINEERED AIR FILTRATION



• Oil bath type filters and filter-silencers • Cleanable filter panels for air-borne dirt, oil, grease and liquids • Oil-wetted type filters and filter-silencers • Exhaust spark arresters • Gear case, crankcase and tank vent breathers • Oil-separators for engine crankcases • Full-flow type cleanable oil filters

5 BASIC REASONS WHY YOU GET . . .

More power-Less wear

WITH COOK'S GRAPHITIC IRON PISTON RINGS

COOK'S GRAPHITIC IRON PLAIN RINGS

"COOKTITE" SEALING RINGS

COOK'S OIL CONTROL RINGS

COOK'S GRAPHITIC IRON Piston Rings

They're *basic* because they account for the superiority of COOK'S Rings in performing the *basic* function of piston rings which is to seal the working clearance between pistons and cylinders—and keep on doing so with minimum wear. Here are the reasons.

1—COOK'S GRAPHITIC IRON—This exclusive material has proven time and again it has unequalled wear-resisting and wear-retarding properties. In terms of performance it means "Longer Ring Life—Less Cylinder Wear".

2—TRUE CIRCULARITY—The ability of COOK'S Rings to maintain true circularity on application to the piston is one of its chief advantages. Operation commences with positive contact between cylinder and ring surfaces all the way around.

3—EXACT FLATNESS—COOK'S Rings provide maximum groove seal and hold ring sticking to a minimum because there is a perfect contact between ring and groove land. COOK'S Rings before grinding are a true machined flat annulus as contrasted with a rough individual casting.

4—TINIZED SURFACE TREATMENT—To provide quick seating properties and to promote rapid mating of ring and cylinder surfaces, COOK'S Rings are coated with a non-scuff anti-friction bearing metal. Break-in time and initial cylinder wear as a result are materially reduced.

5—PERMANENT TENSION—First machined to a true circle, COOK'S Rings pass through a mechanical tensioning machine especially developed to impart a force that holds the rings against the cylinder in a manner that provides permanent and equally distributed unit wall pressure.

All together, these reasons add up to More Power—Less Wear with COOK'S Rings—from the start and all through operation. Try them next time you pull pistons. Prompt shipment on all orders and immediate shipment in emergencies, is rapidly returning as a feature of COOK'S Service.

C. LEE COOK MANUFACTURING CO.

INCORPORATED

LOUISVILLE, KENTUCKY

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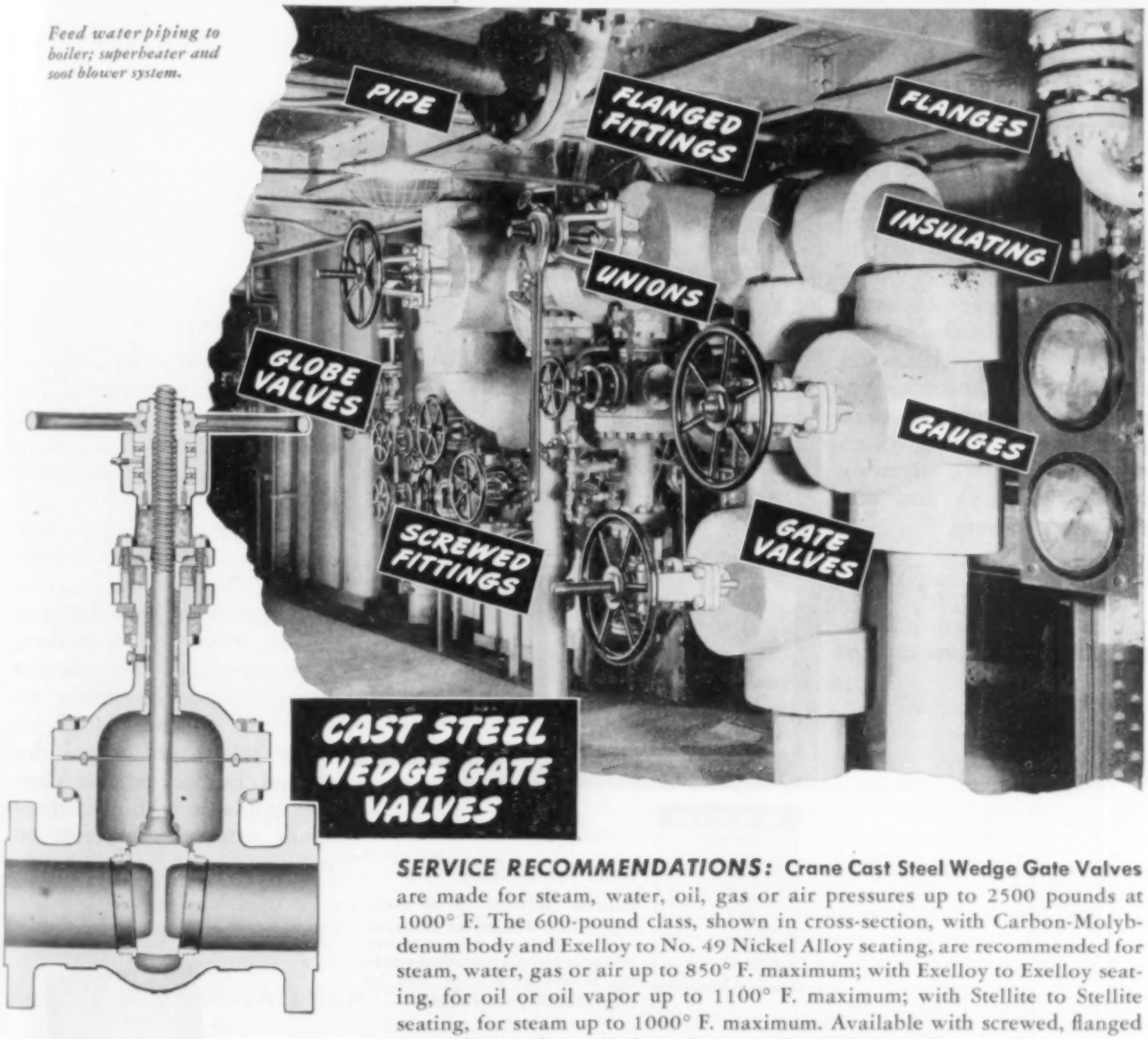
How CRANE Helps Solve Your Piping Equipment Problems

ONE SOURCE OF SUPPLY • ONE RESPONSIBILITY • ONE STANDARD OF QUALITY

If all piping systems worked under the same conditions, the above statement wouldn't mean much. The fact is that you alone can determine the exact requirements governing your choice of piping materials. Here is the vital distinction of the Crane line as a truly helpful service. First, Crane helps by giving you the world's most complete selection of piping equipment for all applications. Then, by making clear the relevant advantages of each type, Crane, with 90 years' experience, helps you choose with complete confidence.

Ordering is simplified—your local Crane Branch or Wholesaler supplies all your needs. Uniform quality in all materials—backed by single responsibility—insures the best installation and peak performance. Stop and think how this service fits your reconversion plans.

Feed water piping to boiler; superheater and soot blower system.



SERVICE RECOMMENDATIONS: **Crane Cast Steel Wedge Gate Valves** are made for steam, water, oil, gas or air pressures up to 2500 pounds at 1000° F. The 600-pound class, shown in cross-section, with Carbon-Molybdenum body and Exelloy to No. 49 Nickel Alloy seating, are recommended for steam, water, gas or air up to 850° F. maximum; with Exelloy to Exelloy seating, for oil or oil vapor up to 1100° F. maximum; with Stellite to Stellite seating, for steam up to 1000° F. maximum. Available with screwed, flanged or welding ends in all sizes. See your Crane Catalog for specifications.

CRANE CO., General Offices: 836 S. Michigan Ave., Chicago 5, Ill. • *Branches and Wholesalers Serving All Industrial Areas*

CRANE — VALVES • FITTINGS • PIPE
PLUMBING • HEATING • PUMPS

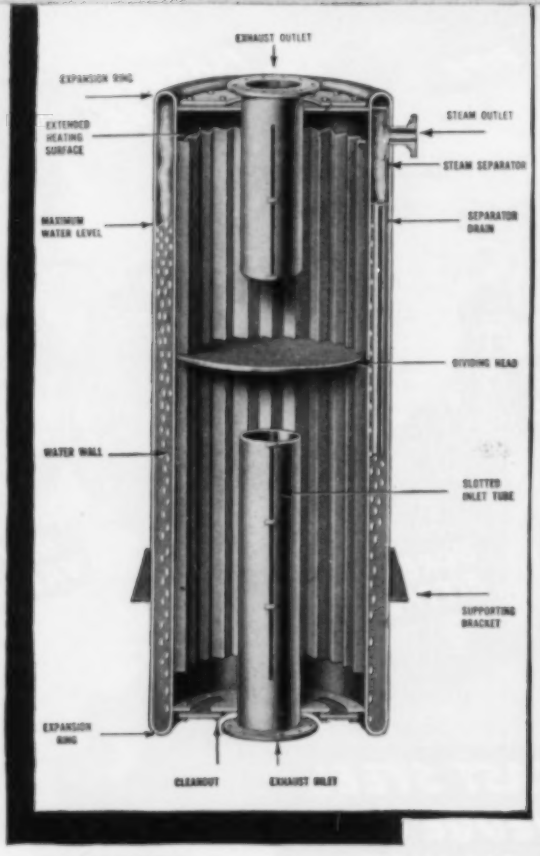
SAVE FUEL

PUT EXHAUST HEAT TO WORK WITH

MAXIM HEAT RECOVERY SILENCERS !

There are few industrial plants that would knowingly throw away fuel, and yet many do just that when they allow engine exhaust heat to escape without making use of it. Maxim Heat Recovery Silencers utilize exhaust heat to produce steam or hot water for heating or processing operations. They combine in one unit effective silencing of exhaust noise, spark arresting (where necessary) and efficient heat recovery.

From an efficiency point of view, the value of using Maxim Heat Recovery Silencers is obvious. Engine exhaust must be silenced as a matter of good public relations. The use of Heat Recovery Silencers accomplishes this and, in addition, produces "fuel-free" steam or hot water.



For silencing without the heat recovery feature, Maxim makes silencers for internal combustion engine exhaust or intake, steam engine exhaust, air compressor intake, vacuum pump discharge, blower intake and discharge, high velocity steam, air or gas discharge. Engine exhaust silencers available with or without spark arrestor. Bulletins on request.

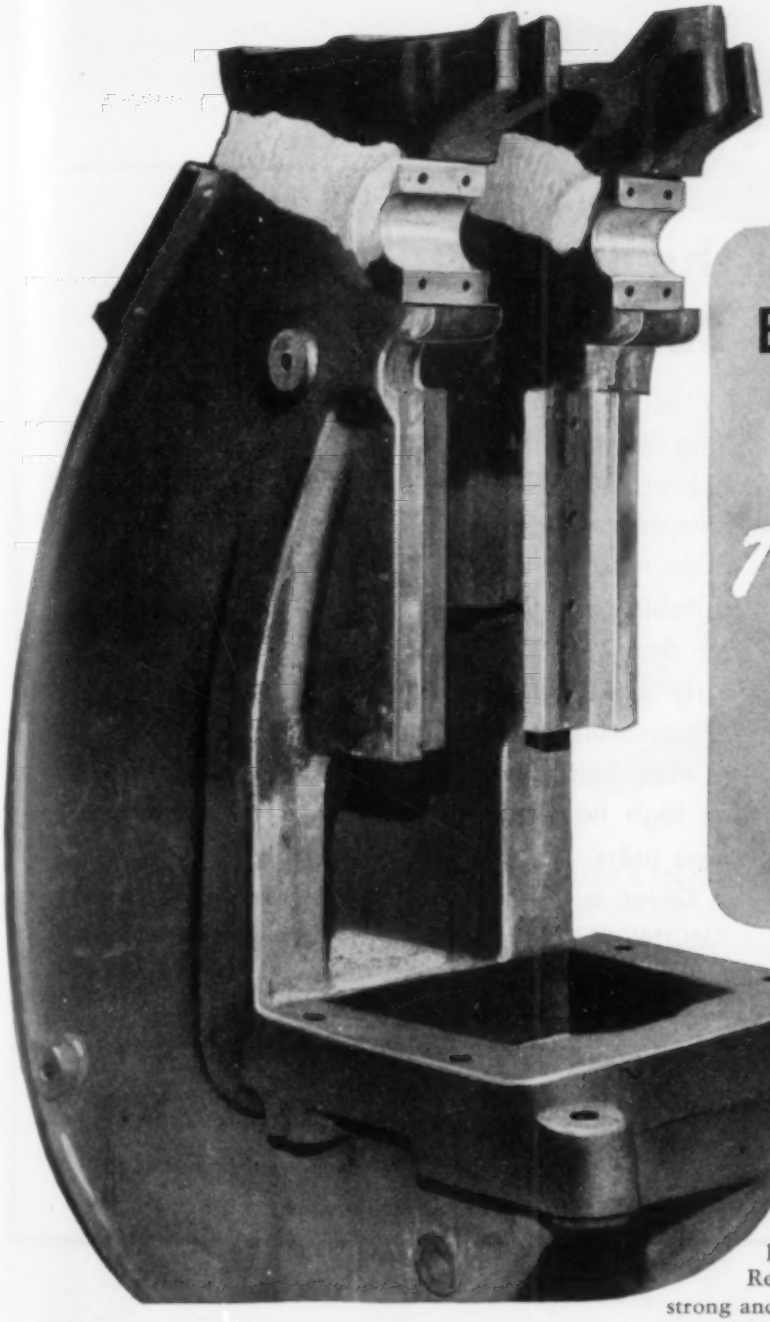
Write for Bulletin

Bulletin WH-101 is an eight page illustrated folder showing various types of heat recovery silencers and also practical working hook-ups. A copy will be sent promptly on request.

THE MAXIM SILENCER COMPANY • 85 HOMESTEAD AVE., HARTFORD, CONN.

ARMY E NAVY

MAXIM



Busy on Bomb Parts, Fractured... TOBIN BRONZE WELDED in 22¼ Hours

ANOTHER EXAMPLE of how Bronze Welding is helping keep vital production tools in action, is this punch press used in producing bomb parts.

Repairs to the cracked frame had to be strong and dependable . . . *and made with minimum delay.* So the Wayne Welding Supply Company, Inc. of Fort Wayne, Indiana used Tobin Bronze*. A total of 60 pounds of ¼-inch rod was required . . . and the work was completed . . . preparation, preheating, welding and finishing . . . in only 22¼ hours.

"Don't scrap it . . . Bronze weld it," is a slogan worth remembering. How to put it to work in your shop forms part of the practical information presented in Publication B-13. This publication also gives detailed information on the complete line of Anaconda Welding Rods. Write for your copy today. 65310

*Reg. U. S. Pat. Off.

What's YOUR experience with BRONZE WELDING?

Tell us what you've accomplished with Bronze Welding in the way of repairs, building up of worn surfaces, production operations, etc. We'll gladly publicize items of general interest for the benefit of all.

THE AMERICAN BRASS COMPANY

General Offices: Waterbury 88, Connecticut

Subsidiary of Anaconda Copper Mining Company

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Buy Victory Bonds . . . Help Assure World Peace

ANACONDA

Anaconda Welding Rods

MONOBELT
(PATENTED)

the Modern Belt for Compressor Drives

By its superior performance and exceptionally long life, this pliable, tough, durable, waterproof belt has won the preference of operators in the compressor field.

Its modern construction renders it especially suitable for operation on high speed, short center drives with increased efficiency . . . particularly on pivoted motor base drives operating compressors.

Monobelt's ability to withstand shock loads and its high horsepower capacity is astounding to new users.

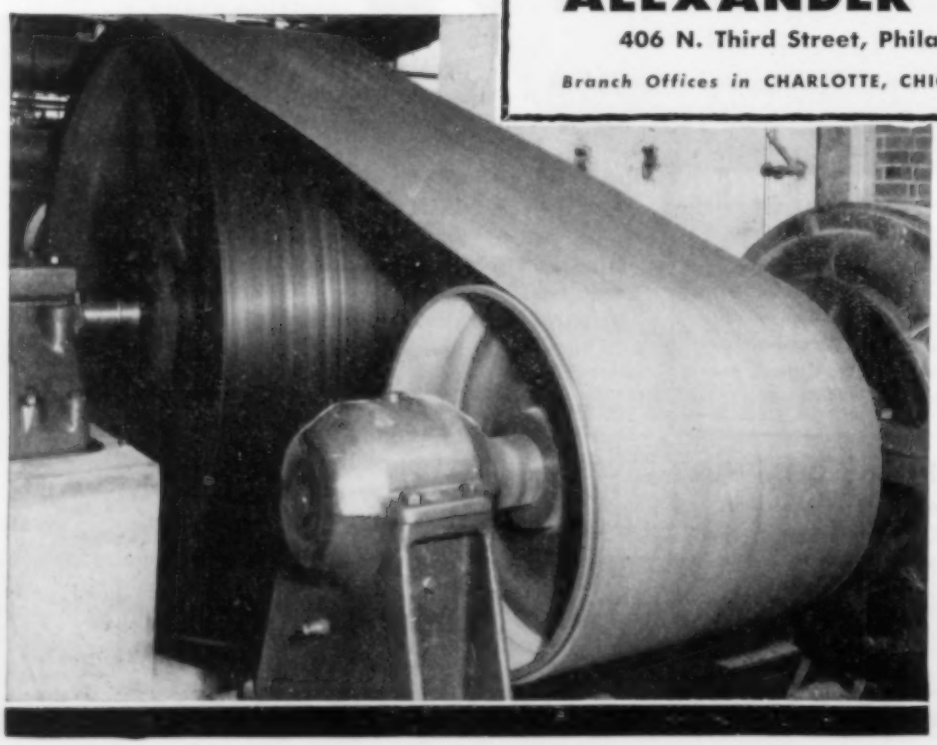
Given a factory run-in before being shipped, "MONOBELT" is ready to "go to work" the instant it arrives in your plant.

Send for Illustrated Catalog

ALEXANDER BROTHERS

406 N. Third Street, Philadelphia 23, Penna.

***Branch Offices in* CHARLOTTE, CHICAGO, DALLAS, NEW YORK**



Here's a **MONOBELT** on a typical short-center compressor drive.

THE OTHER INGREDIENT

AIR

This is not a recipe for the world's best loaf of bread—nor a sales talk for the virtues of vitamin rich yeast. However, both are very much dependent upon the use of compressed air . . . for without air there would be no yeast, and without yeast there would be no bread.

A modern yeast vat produces two and one-half tons of yeast in an eleven-hour "growing" period. During those eleven hours, ***fifty-five tons of air*** are blown through the vat to aerate and agitate the contents. Very little of this air remains in the final product, but its use is essential to the commercial yeast process.

Blowing yeast vats is but one of the many uses of Ingersoll-Rand Turbo Blowers—they play an important part in the production of iron and steel, copper, and other metals, and in the manufacture of gas and many types of ceramic products.

For every one of the industrial jobs that requires the use of compressed air, Ingersoll-Rand makes the machine to compress it, also many of the tools that use it. That is why our engineers, after studying your problems, will be able to help you select the proper equipment for any application.

Ingersoll-Rand

11 BROADWAY, NEW YORK 4, N. Y.

12-730

COMPRESSORS · CONDENSERS · TURBO BLOWERS · CENTRIFUGAL PUMPS · ROCK DRILLS · AIR TOOLS · OIL AND GAS ENGINES

FOR ASSURED VALVE PERFORMANCE

consult Powell Engineering first

LET'S BE SURE THE EQUIPMENT FITS THE JOB!

Everyone knows it would be silly to enter a Draught Horse in a race. On the other hand, a Thoroughbred wouldn't last long pulling a heavy load. But unless you're an expert valve engineer, it's not so simple to determine what type, design and material a valve should be to do a specific job. Powell Engineering, with a background of almost a century of research, experimentation, and practical experience, will be glad to assist you in selecting the correct valves to meet your particular flow control requirements.

The Wm. Powell Co., Cincinnati 22, Ohio

DISTRIBUTORS IN PRINCIPAL CITIES

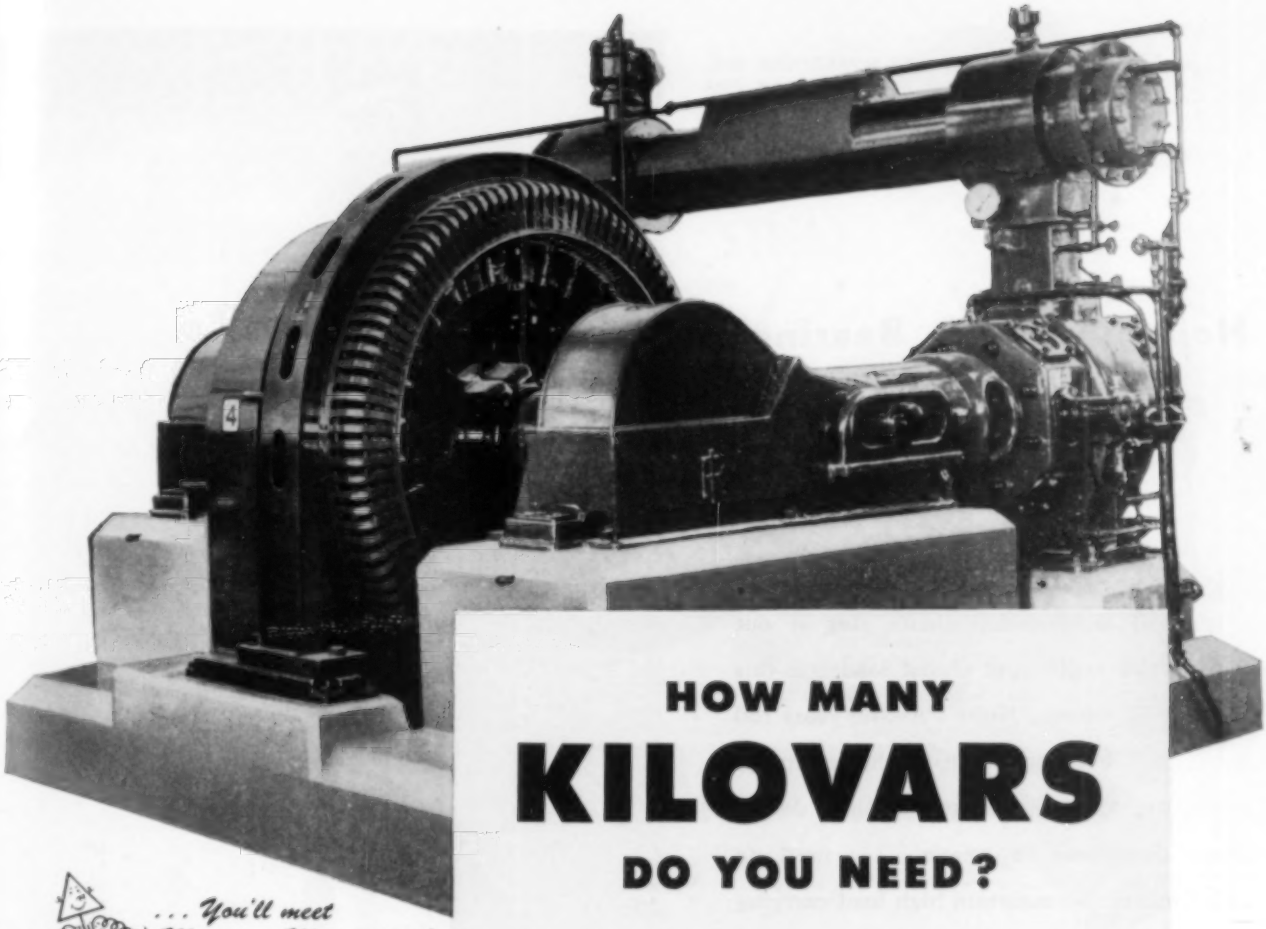
The illustrations show a few of the POWELL Valves especially adapted for compressed air service.

Fig. 1793—125-pound Iron Body Bronze Mounted Gate Valve, with flanged ends, outside screw rising stem, bolted flanged yoke, bronze seat rings and taper wedge solid disc. Also available with taper wedge double disc —Fig. 1444.

Fig. 559—125-pound Iron Body Bronze Mounted Swing Check Valve, with flanged ends, bolted flanged cap and regrindable, renewable bronze seat and disc.

Fig. 241—125-pound Iron Body Bronze Mounted Globe Valve, with flanged ends, outside screw rising stem, bolted flanged yoke and regrindable, renewable bronze seat and disc.

POWELL VALVES



HOW MANY KILOVARS DO YOU NEED?

... You'll meet Mortimer Magnetizer!

FREE! 20 page booklet, "ABC of Power Factor". Brand new; packed with authentic data, fully illustrated.

KILOVARS are required from the power line to magnetize your induction motors. To help relieve overloaded plant wiring, to improve plant voltage, and in many cases to reduce power costs, Synchronous Motors can furnish these kilovars *right in your own plant.* In thousands of applications, E-M Synchronous Motors cooperate to minimize power bills by correcting plant power factor . . . plus furnishing most efficient motor drive.

Profitable use of these *double-duty* Synchronous Motors is universal. A look around your plant will suggest ways to gain these benefits. It may be a leading power factor Synchronous Motor to drive a compressor, pump, fan, crusher, mill line or other applications calling for large, constant-speed drives. Let the E-M field engineer—expert in power factor improvement and synchronous motor drives—help you meet your reconversion or modernization plans now.

WRITE TODAY . . . **ELECTRIC MACHINERY MFG. COMPANY**

MINNEAPOLIS 13, MINNESOTA

E-M

LOW-SPEED

HIGH-SPEED

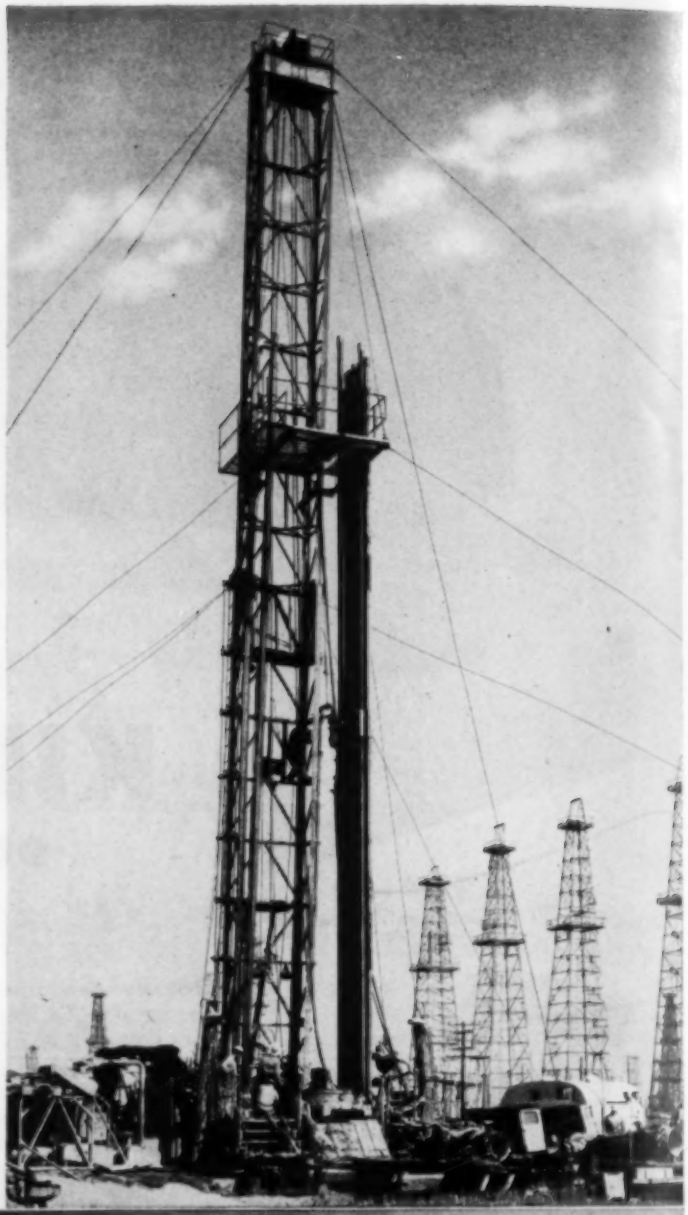
IT PAYS TO USE SYNCHRONOUS MOTORS ...THEY PAY FOR THEMSELVES BY CORRECTING POWER FACTOR

ENGINE-TYPE

"PACKAGED"

A-2019

● *Unit, BUILT BY WAGNER-MOREHOUSE, INC., with Ideco 90' Kwik-Lift Derrick; net hook capacity, 250,000 lbs.*

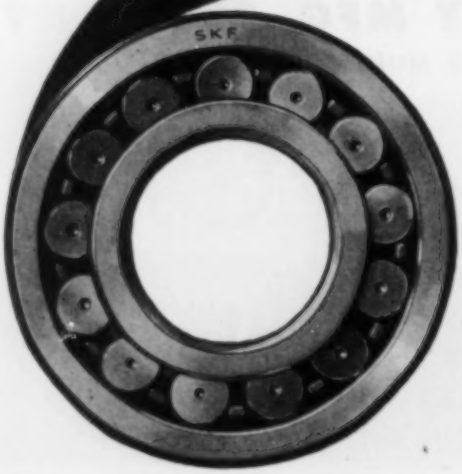


Hoisting Needs Bearings

With Guts!

Twelve SKF Bearings on drum, counter, drive and transmission shafts slug it out with heavy radial and thrust loads on this Wagner-Morehouse Hoist. As the years roll by, SKF's, having built-in aligning properties, overcome the dangers of shaft deflections, distortions or weave . . . need no adjustments . . . maintain high load carrying capacity and equalized load distribution at all times. Wherever there's an SKF in the oil fields, there's *guts* for tough jobs. 5820

SKF INDUSTRIES, INC., PHILA. 34, PA.



SPECIFY

SKF

BEARINGS

Sure, you can get made-up BETHLEHEM HOLLOW DRILL STEEL *from your converter!*

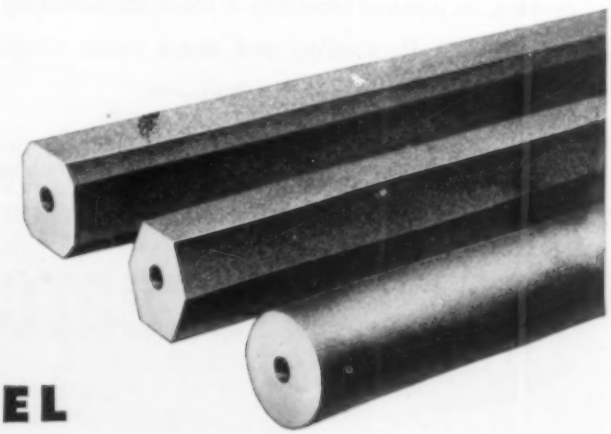
Ask for it by name. Your local converter has it or can make it up for you. When he supplies you with Bethlehem Hollow Drill Steel, you're killing two birds with one stone. You're not only buying as fine a hollow drill steel as the market affords, but you're getting streamlined service.

Your converter knows local conditions. He knows what to do when you're drilling through shale, trap-rock, granite, limestone, or sandstone. He knows the drilling equipment you use and how you use it. He's an expert at making up new Bethlehem drill steel. He knows how to heat-treat it accurately and do a fine redressing job.

Moreover, in spite of shipping problems, he's able to give you good delivery; good, quick service on redressed steel.

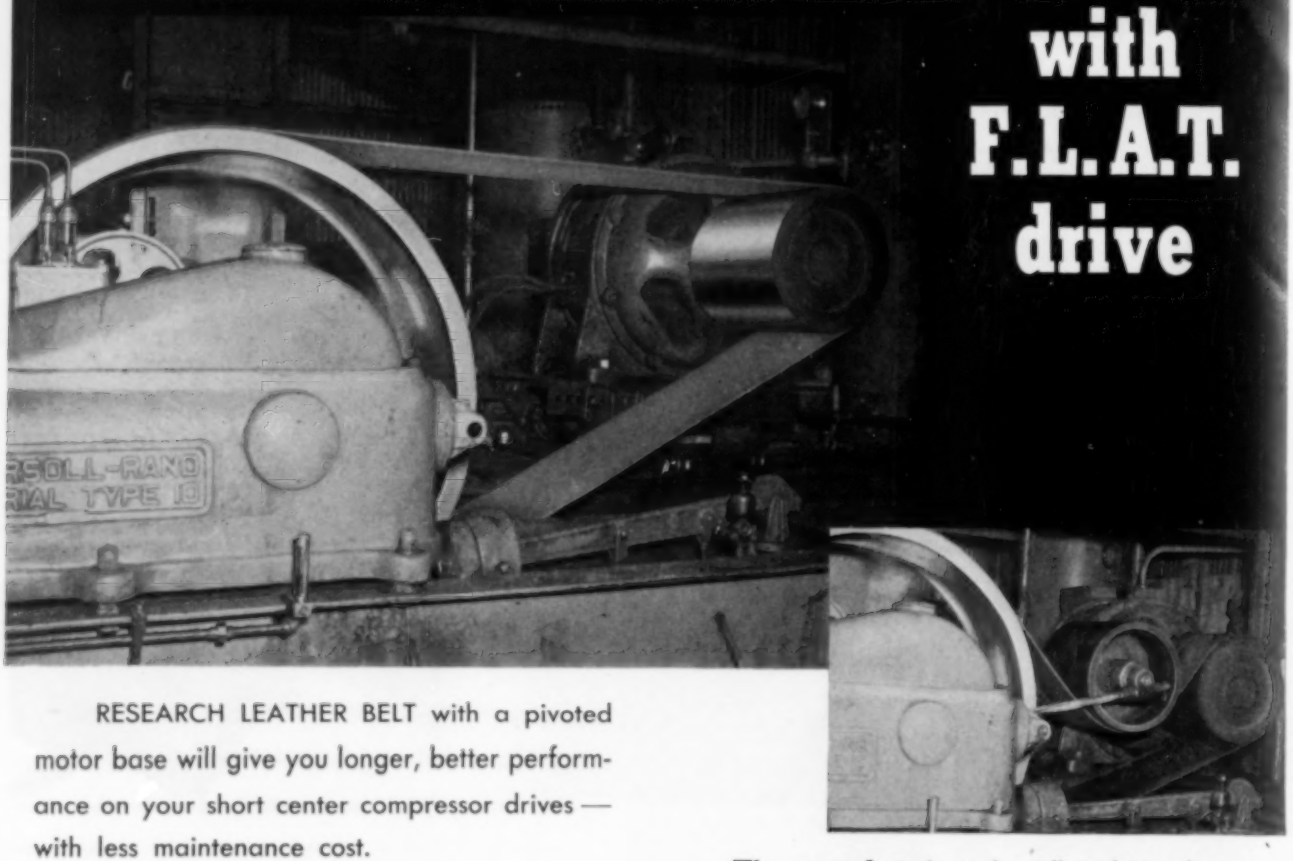
When a converter supplies and services your Bethlehem Hollow, you've got a combination that's hard to beat. Steel that's uniform; steel that's true to size and highly fatigue-resistant; steel with a smooth, well-centered hole . . . PLUS the kind of service that helps you meet your contract dates.

★ BETHLEHEM STEEL ★



BETHLEHEM
HOLLOW DRILL STEEL

DEPENDABLE, TROUBLE-FREE SERVICE with F.L.A.T. drive



RESEARCH LEATHER BELT with a pivoted motor base will give you longer, better performance on your short center compressor drives — with less maintenance cost.

The Flat Leather Automatic Tension drive automatically provides proper tension through the action of the pivoted base.

Research leather belting provides minimum stretch and maximum pulley grip. The special manufacturing processes used in its manufacture give it high tensile strength and great flexibility for use with extreme pulley ratios and short centers. Its natural elasticity is ideal for handling the varying, fluctuating and shock loads which characterize compressor drives.

The proof: When the idler drive shown in smaller illustration caused maintenance grief and belt wear, Graton and Knight engineers recommended a pivoted base and Research Belt. The large illustration shows the result. Drive data: Motor, 100 H.P., 870 R.P.M.; motor pulley, 16" x 16"; driven pulley, 48" x 16"; center distance, 58"; pivoted base, Rockwood #14.

This modern F.L.A.T. drive transmits more power, eliminates idler bearing replacement and increases belt life. Moreover, there has been **no maintenance expense** since this drive was installed over two years ago.

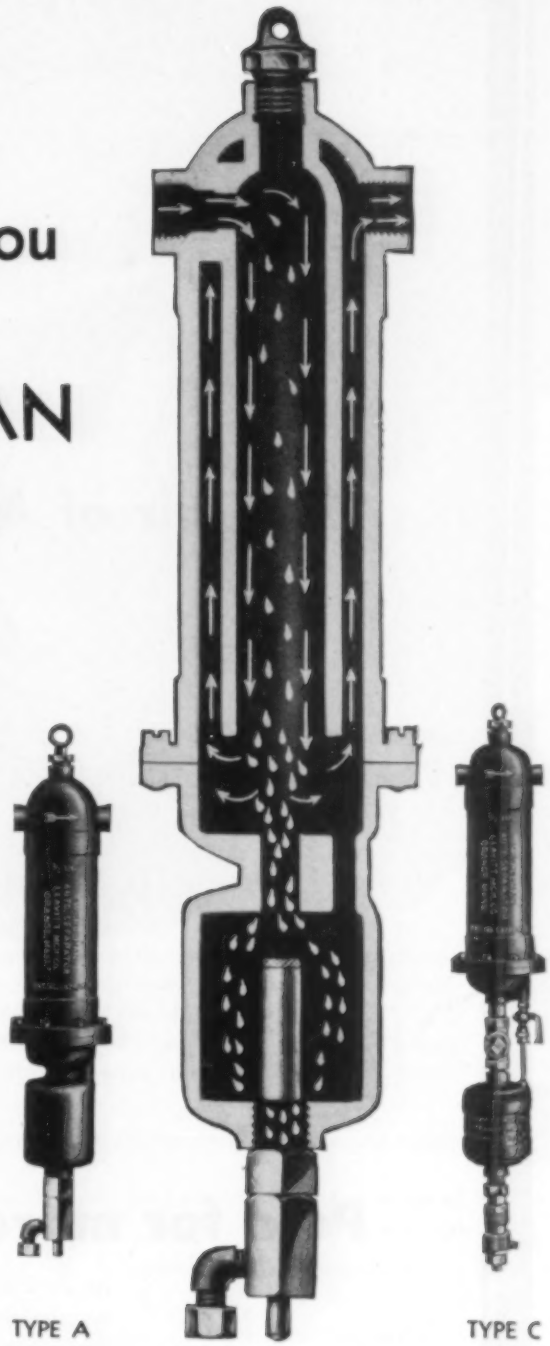
Write Graton and Knight Company, 365 Franklin St., Worcester 4, Mass., for 56-page belting manual giving engineering data on this and other types of drives.

GRATON AND KNIGHT

Research Leather Belting

The most complete line . . . manufactured under one control from green hide to finished product. Graton & Knight distributors are listed under "Graton & Knight" in "Belting" section of Classified Telephone Directory and THOMAS' REGISTER.

DIRTY AIR can cost you more than the DEXTER SWENDEMAN Automatic Separator!



TYPE A TYPE C

It's a fact that many a plant using ordinary compressed air is wasting more money because of oil, water and dirt in the air lines than the entire cost of Dexter-Swendeman Automatic Air Separators.

Increased power, elimination of ice formation and rust, and clean, smooth work as in spray painting, are immediate results that make Swendeman Equipment a worthwhile investment.

Oil, water and dust are continuously ejected from the system—not trapped to require further attention or return to the air stream. This is the great feature that makes the Dexter-Swendeman Separator fully automatic, trouble-free and efficient.

Write today for detailed literature showing how you can secure clean, moisture-free air for your particular uses the economical way—the Dexter-Swendeman way!

A-5

SWENDEMAN
Automatic Air Separator
A DEXTER PRODUCT

The LEAVITT MACHINE COMPANY
ORANGE, MASSACHUSETTS

This Pair of AO Goggles

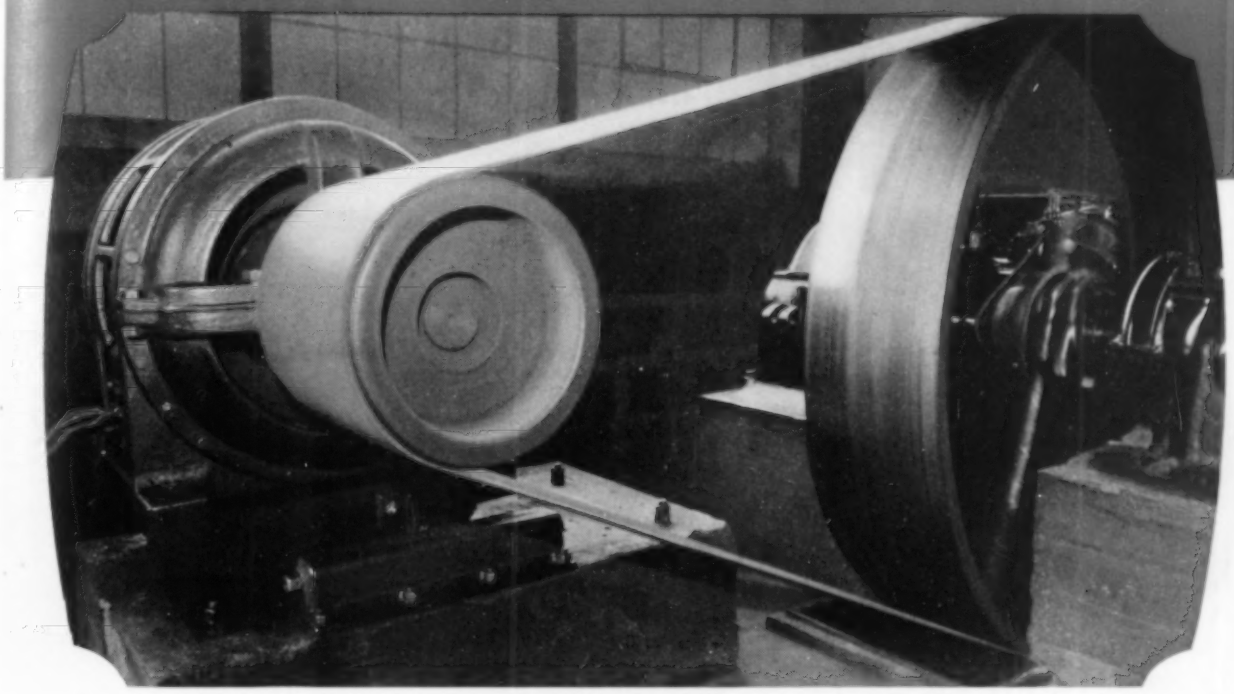
Paid for more than a Hundred Others

That's a conservative statement, for the average eye accident costs $343 for medical expenses and compensation, and safety goggles cost only about $1.50 per employee.
An AO Safety Representative will be glad to consult with your Safety Director and help work out a sound program for lower costs through safer methods.

American Optical
COMPANY
SOUTHBRIDGE, MASSACHUSETTS

"We Anticipate Greatly Prolonged Belt Life—"

...Writes the Chief Engineer of this Paper Mfg. Co.



Tannate-Rockwood Drive operating an Ingersoll-Rand compressor at the Hamersley Manufacturing Company, Inc., Garfield, N.J. Writes Mr. George Moreland, Chief Engineer, "The new drive seems to work very smoothly . . . we anticipate a greatly prolonged life for the belts on this job."

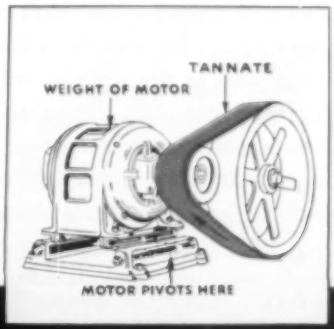
This installation replaced a short center drive with a 300-pound idler pulley which caused heavy wear on the belts used previously. 22" Driver pulley; 96" Driven pulley; 8'8" Center. 150 HP motor, 695 rpm. Installed November 1944.

In paper making, as in other lines, Tannate-Rockwood Drives are proving most satisfactory, reliable and economical day in and day out.

Correct belt tension is maintained, and automatically adjusted to changing load conditions, by the weight of the motor on the pivoted base. This assures maximum power transmission efficiency . . . operation is steady, with little or no maintenance.

TANNATE Belting is preferred with this drive because TANNATE is stronger, tougher, more flexible . . . with a firm pulley grip that keeps the machine running steadily, at full capacity. TANNATE has the stamina and endurance for a long life of service.

In your plant, Tannate-Rockwood Compressor Drives would probably also prove efficient and economical. May we give you more information by mail or by having a Rhoads Service Engineer call?



J. E. RHOADS & SONS 35 N. SIXTH ST., PHILA. 6, PA.
Established 1702 NEW YORK · CHICAGO · ATLANTA

RHOADS

Tannate-Rockwood

SHORT CENTER DRIVE

WALWORTH LUBRICATED PLUG VALVES

offer these advantages

- . . . Direct port opening
- . . . Quarter turn opens or closes valve
- . . . Dead tight shut-off
- . . . Freedom from attack by fluids being handled
- . . . Pressure sealed
- . . . Made in a complete line. Sizes from ½" to 24" for pressures from 125 to 5,000 psi., and for vacuum requirements

THESE are just a few of the reasons why Walworth Lubricated Plug Valves give "top" performance on many *difficult* services.

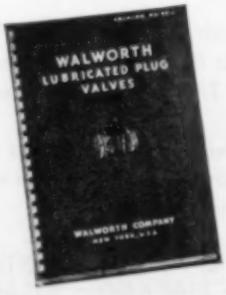
All Walworth Lubricated Plug Valves employ special insoluble lubricants which protect the plug and body against contact with the line fluid, thus combatting erosion and corrosion.

The lapped surfaces of the valve are "pressure sealed" when the valve is in either the open or closed position. By turning the lubricant screw, lubricant is forced under high pressure through a grooving system that completely encircles the parts as well as the top and bottom of the plug.

The lubricant seals the valve against leakage, and reduces friction between plug and body. This permits easy, quick, full-opening, or tight shut-off with only a quarter turn of the plug.

Fig. 1700 (illustrated) is a Steeliron valve, wrench operated, designed for a working pressure of 200 pounds WOG (water, oil, or gas). Valves are available in either screwed or flange types. Screwed type have API line pipe thread lengths. Flanged type are faced and drilled to American Standard for 125-pound cast iron flanges unless otherwise specified.

For further information about Fig. 1700, as well as the complete line of Walworth Lubricated Plug Valves write for Catalog No. 44L.



SEND FOR THIS FREE CATALOG

This new Walworth Lubricated Plug Valve Catalog No. 44L is just off the press. It gives prices, sizes, dimensions, and other pertinent data on this comprehensive line. A request on your company's letterhead will bring you a free copy of this informative catalog.

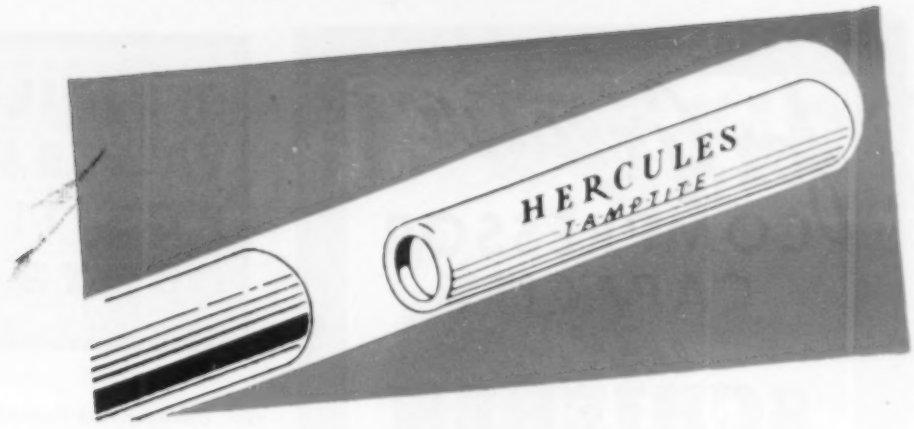
14 AWARDS TO 4 PLANTS

WALWORTH

valves and fittings

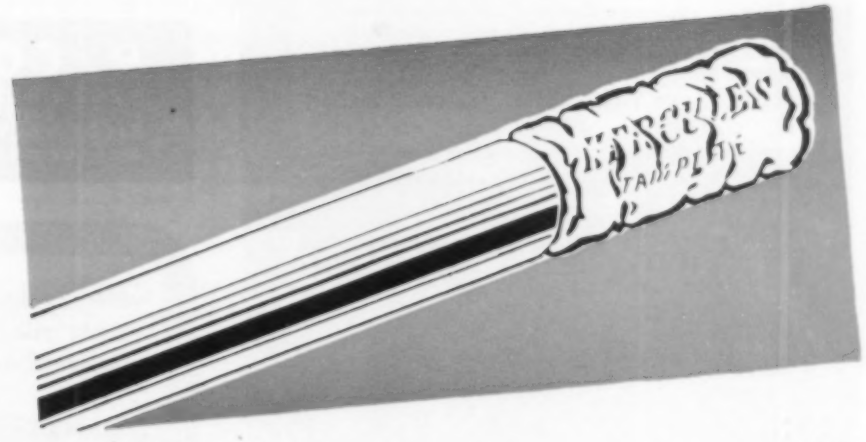
60 EAST 42nd STREET, NEW YORK 17, N. Y.

DISTRIBUTORS IN PRINCIPAL CENTERS THROUGHOUT THE WORLD



TAMPTITE

SAVES MAN-HOURS



You save time, labor, and expense with Hercules explosives in Tamptite cartridges—important savings in a period of manpower shortages.

You drill and tamp in the usual way, using your favorite Hercules explosive. But when you tamp a Tamptite cartridge, the dynamite expands to fill the bore hole snugly, leaving virtually no air space. (No need to slit cartridges and risk spilling powder.) The charge is concentrated where it is most effective.

Result: Better breakage of the ore or rock, speedier mucking, a faster mining cycle. Man-hours saved!

Hercules Gelamites, Hercomites*, Extra Gelatins, Gelatins, and Extra Dynamites —in small sizes for mining, quarrying, and construction—are furnished in Tamptite cartridges. This is another reason for specifying Hercules.*

HERCULES

EXPLOSIVES DEPARTMENT, HERCULES POWDER COMPANY INCORPORATED 932 KING STREET, WILMINGTON 99, DEL.

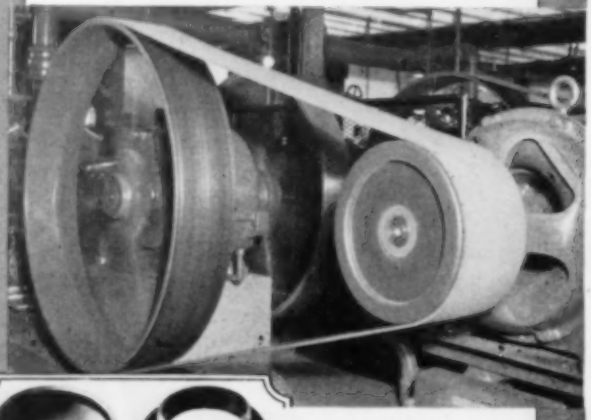
Reg. U.S.Pat. Off. by Hercules Powder Co.

XR-53

for Greater
COMPRESSOR CAPACITY
use
SCHIEREN
FLAT LEATHER BELTING

For better pulling grip and the least slip, nothing surpasses SCHIEREN FLAT LEATHER BELTING. And that means no decrease in compressor capacity no matter what load changes come. SCHIEREN LEATHER BELTING combined with the the constant, automatic, correct tension of pivoted motor bases on short centers assures maintenance-free power delivery. Write for full information and our estimate on your next drive. There's no obligation to order.

National Distributors of Rockwood Bases



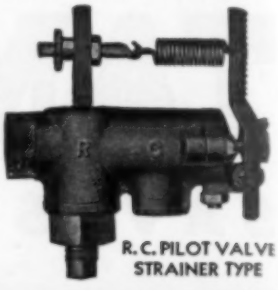
SCHIEREN QUALITY LEATHER PACKINGS

For every usual and unusual requirement, Schieren Leather Packings give you lower annual packing cost and high production efficiency. Send for catalog.

CHAS. A. SCHIEREN CO.
LEATHER BELTINGS • SPECIALTIES
HYDRAULIC PACKINGS
30 FERRY STREET, NEW YORK 7, N. Y.
60 FRONT STREET, WEST, TORONTO, ONTARIO

R. C. PILOT VALVES FOR POSITIVE CONTROL

R-C Unloader Pilot Valves (plain or strainer type) are standard on many leading compressors . . . installed as replacements on thousands of compressors in all parts of the U. S. A. and overseas. The R-C valve—positive in action—cannot chatter . . . it's always in open or closed position. Adjustment is provided for any unload-to-load range from 3% to 30% of maximum receiver pressure. Install an R-C Unloader Pilot valve—let performance prove its value. Specify air pressure and range of on-and-off operation desired. Write for price and recommendation.

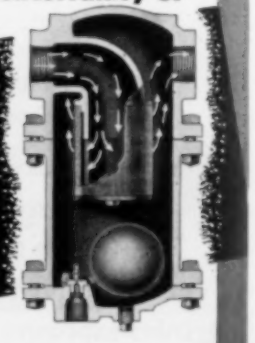


R. C. PILOT VALVE STRAINER TYPE

R. CONRADER CO.
1207 FRENCH STREET - ERIE, PA.
PILOT VALVES for Portable and Stationary Air Compressors provided with Unloaders

✓Eliminates need for external traps
✓Ends the bother and uncertainty of manual draining

The NEW Johnson SELF DRAINING Compressed Air Separator



• Here is the time-proved Johnson Separator with a complete trap mechanism built right in—today's newest idea in Separator design. It combines the two best principles of separation—first allows the air to expand slightly, then changes direction of flow abruptly many times with the "thousand baffles"—removes more than 99% of water, dirt and oil. The simple trap mechanism, mounted on bottom plate for easy access, releases the accumulated moisture from the Separator, automatically, whenever necessary.

Johnson Separation Devices include Separators for Compressed air or Steam, After Coolers, Oil Absorbers.

WRITE FOR CATALOG

The Johnson Corporation
830 WOOD STREET (J) THREE RIVERS, MICHIGAN

Designed for Digging

Working with the intimate knowledge of field problems that comes only from years of experience and with ample modern facilities for research and manufacture at their command, Bucyrus-Erie engineers are in an unequalled position to design machines scientifically adapted to the work to be done. Every part of a Bucyrus-Erie, whether made in our own shops and foundries or purchased from an outside supplier, must pass our rigid laboratory tests before being released for production.

Study the design of a modern Bucyrus-Erie, watch the smoothness with which the machine works, and you will readily recognize that there are no design "compromises" to pile up power consumption, result in excessive maintenance, or reduce output. From the ground up, Bucyrus-Eries are designed for digging. That's why leading operators all over the world say that Bucyrus-Eries are "years ahead."

4L45

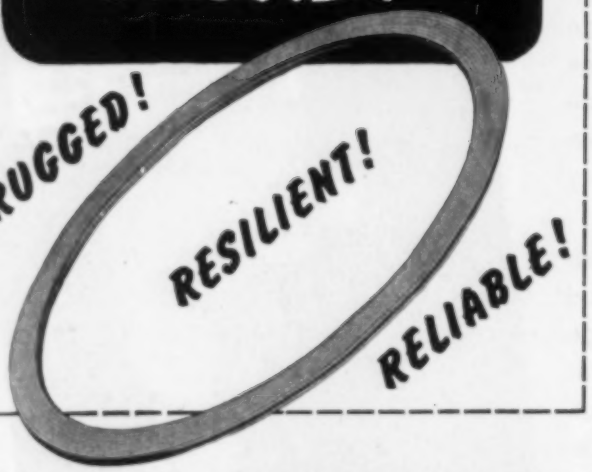
Modern electric furnaces in our own foundries . . . one of the facilities permitting full scope for design.

BUCYRUS ERIE

SOUTH MILWAUKEE, WISCONSIN

THE GARLOCK

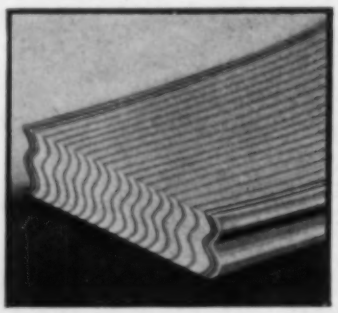
GUARDIAN GASKET



Safety against extreme temperatures and pressures. Metal and asbestos are the only materials used in the construction of Garlock Guardian Gaskets. They are unaffected by temperatures or pressures encountered in any gasket installation.

Resistance to gases and liquids. Garlock Guardian Gaskets are protected on their inner and outer edges by a double thickness of metal which forms an impregnable barrier to the destructive action of gases and liquids.

Tight joints under changing temperature conditions. Because of their unique structural design, Garlock Guardian Gaskets adjust themselves instantly and repeatedly to expansion and contraction due to temperature changes or vibration.

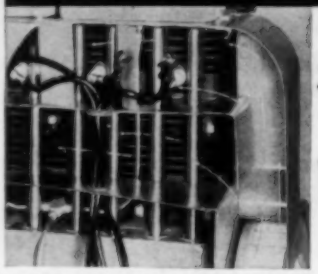


THE GARLOCK PACKING COMPANY
PALMYRA, NEW YORK

In Canada: The Garlock Packing Company of Canada Ltd., Montreal, Que.

GARLOCK

~~AIR~~ in Abundance..



but it's SCIENTIFICALLY "RATIONED" for WISCONSIN ENGINES

The amount of air required for cooling the lower half of an engine cylinder won't do for the "business end", where the highly compressed fuel charge explodes.

With a continuous, large-volume air-flow to draw from, Wisconsin engineers have long since figured out just how much air to *ration* to each section of the engine, for most efficient cooling.

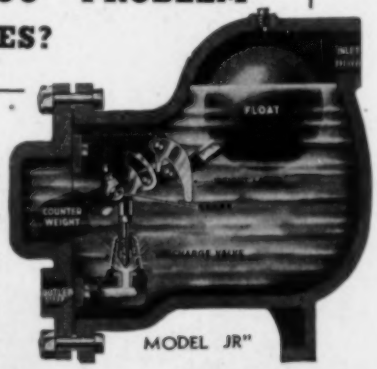
This is important in relation to the satisfactory performance of *your* power-operated equipment.

Most H.P. per pound

WISCONSIN MOTOR Corporation
MILWAUKEE 14, WISCONSIN, U. S. A.
World's Largest Builders of Heavy-Duty Air-Cooled Engines

HAVE YOU "PROBLEM" AIR LINES?

For Trouble-Shooting and Increasing Efficiency... Install



NICHOLSON
COMPRESSED AIR TRAPS

They are plant-proved to be "America's fastest acting compressed air trap". Due to their exclusive weight-operated design they open and close instantaneously, giving full, positive, trouble-free drainage of water and oil. For most air applications, pressures to 200 lbs.

Write for Bulletin 341

W. H. NICHOLSON & CO.
180 OREGON ST., WILKES-BARRE, PA.
Valves ★ Traps ★ Steam Specialties

Fresh Oil

FED UNDER PRESSURE BY THE MEASURED DROP

Six Popular Models for Every Application

Madison-Kipp Lubricators provide the most dependable method of lubrication ever developed, and there are six popular models for every application. Madison-Kipp specializes in lubricators for original and standard equipment. Write for special engineering data for your particular equipment.

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Sole Agents in England: Wm. Coulthard & Co., Ltd., Carlisle

They taught Oil and Rubber to get along

and made a better

PISTON PACKING CUP

THE wide range of service conditions that piston packing cups must meet in industry calls for something special in service qualities. Wabco packing *has* these qualities—thanks to Westinghouse research.

Various materials were investigated in an extended search for the best packing material. Rubber had the greatest promise, but it couldn't stand oil. The Research Department kept digging, and finally came up with a formula that could live with lubricants and still retain its resilience, mechanical strength and sealing properties under severe service conditions.

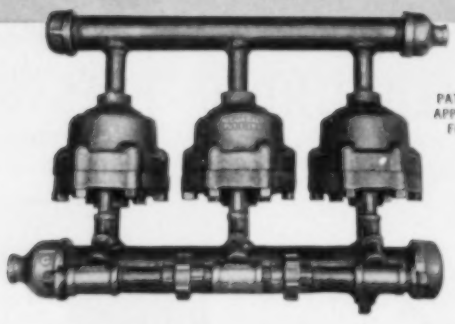
In addition to these service qualities, Wabco packing offers an important exclusive mechanical feature. Built-in limited compression, available in cups from 1-inch to 7½-inch, assures low friction.

Wabco packing cups are available in sizes from ¾-inch to 30-inch, for original installation in pneumatic cylinders; from $1\frac{3}{16}$-inch to 7-inch for hydraulic cylinders. If your product includes such cylinders, you will find Wabco cups an economical, simple, and dependable solution of your packing problems.

Westinghouse Air Brake Co.

Industrial Division - - - Wilmerding, Pa.

Purify Any Pressures, Air or Gas, with Bird-White Multiple Unit *Pur-O-fier*



PATENT APPLIED FOR

Three Models Available

Model A-1 furnished with a 1 inch turbo-rotor and will accommodate volumes from 1 to 8 cubic feet.

Model A-2 has a 2 inch turbo-rotor and can accommodate volumes from 10 to 35 cubic feet.

Model A-4 has a 4 inch turbo-rotor and can accommodate volumes from 35 to 100 cubic feet.

Bird-White multiple unit Pur-O-fiers save time and money by protecting air-operated machines, gauges and controls from contamination. They give positive purification to air or gas lines regardless of fluctuating pressures or high volumes.

The perfectly balanced Turbo-Rotor purifying action makes them sensitive to both regular and intermittent pressures. Write for Bulletin 10 giving complete details.

BIRD-WHITE COMPANY
Dept. CA, 3119 WEST LAKE STREET
CHICAGO 12, ILLINOIS

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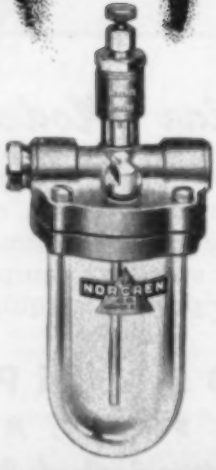
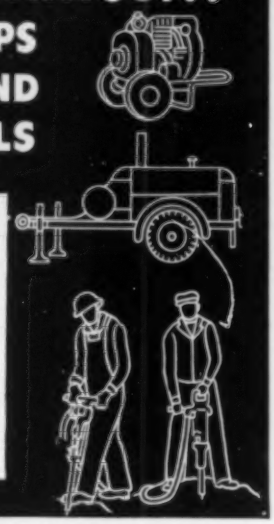


Norgren Lubricators in the air lines protect your air driven tools and cylinders from costly repairs, with "air-borne" lubrication. Automatically inject exactly the right amount of oil into the air stream, creating an "oil fog" that travels with the air. This lubricates ALL moving parts when the tool is working. Prevents rust and corrosion when the tool is idle. Pays for itself *in a hurry!*

Write C. A. Norgren Co., 220 Santa Fe Drive, Denver 9, Colorado.

Norgren

Quality PACKINGS...
FOR YOUR PUMPS COMPRESSORS AND PNEUMATIC TOOLS



GOODALL V-RING PACKINGS . . for piston and valve stem applications. Will outlast regular coil packings two-to-one, and are 50% more efficient.

GOODALL SUPERHEAT SHEET PACKING. Compressed rubber and asbestos. For all high temperature, high pressure flange connections. Durable, efficient, economical.

Ask our engineering department for specific recommendations. No obligation.

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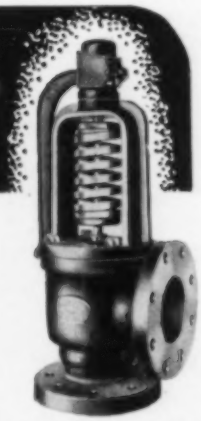
Factory • Trenton, N. J. Established 1870

For Accurate Control



This FARRIS Safety Valve No. 2350 has high-lift disc action which secures HI-Capacity Relief . . . for HI-Pressure, HI-Temperature work. Precision machining of every finished surface secures close tolerances, precision operation.

"Precision alignment" of spring, stem. disc guides, and seat, protects this FARRIS valve against sticking and other performance-failures. Economical first-cost and very low (if any) maintenance expense.

Built in bronze, cast steel, and semi-steel for pressures to 600 lbs. at 750° F. Sizes ½" to 6" x 8". Meets ASME requirements.

Write today for Bulletin on our complete line of Safety and Relief Valves.

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SAFETY and RELIEF VALVES

IS YOUR COMPRESSOR WORKING AT "PICK AND SHOVEL" EFFICIENCY?

Pick and shovel methods won't do the same jobs you expect from the modern Rock Drill, Stone Breaker or other pneumatic tool . . . that's why you can afford to make a heavy investment in highly efficient specialized compressor equipment.

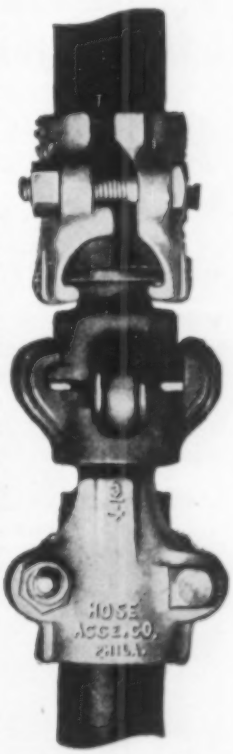
But, from this investment in primary equipment, are you getting only "pick and shovel" efficiency when the rated pressure load isn't delivered all the way to your tools?

Why jeopardize thousands of dollars of investment by losing a good part of the power you are paying for because of faulty hose couplings and fittings? Costly pressure is too often blown away because of leaks . . . and never even noticed.

The answer is simple. To insure against leaks and costly breakdowns on your hose lines, demand LE-HI Hose Couplings for all pneumatic tool applications, pile driving equipment, low or high pressure air or steam applications and for discharge, suction or water hose service.

Your distributor knows the complete LE-HI Line, or write direct today.

Send for your copy of the new LE-HI Service Manual. Revised and enlarged to include many important facts that will aid you in obtaining better performance from your equipment. Write today for the LE-HI HOSE COUPLING HAND BOOK AND SERVICE MANUAL



Series 100 Universal Type Hose Coupling attached to hose with Series 10 Hose Clamp. Quickly and easily coupled or uncoupled . . . yet they lock securely. For compressed air lines and many special uses.

Series 500 High Pressure Male Hose Coupling. The companion male unit for LE-HI Series 400. Adaptable to the widely diversified applications where the female units are used.

Series 400 High Pressure Female Hose Coupling. Will do the job wherever air, gases, water, steam or liquids are conveyed through hose. Used in every type of construction and industry.

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A DIVERSIFIED LINE FOR CONSTRUCTION AND INDUSTRIAL HOSE APPLICATIONS

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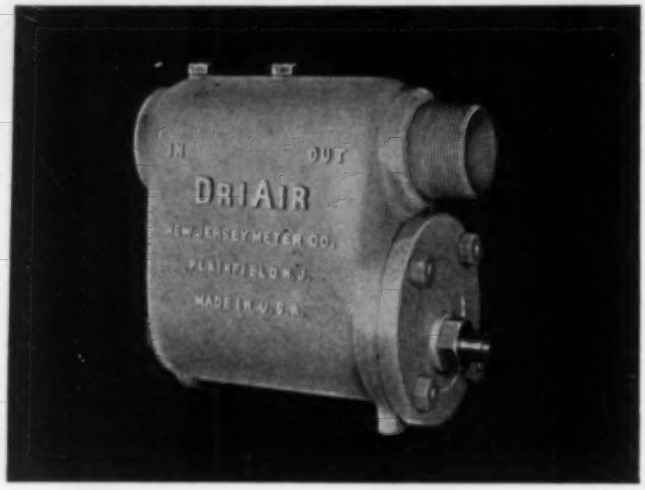
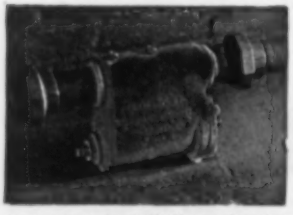


WHEN EQUIPMENT IS PROTECTED BY

DRIAIR

A COMPLETE SELF-CONTAINED UNIT

DriAir may be installed by suspending it from the piping without any other support.



A typical installation showing DriAir standing on the floor next to the wall.

The answer to many problems which arise in various applications of compressed air, DriAir speeds production by separating and automatically ejecting the condensed water and oil from the air. DriAir collects dirt and rust from the air lines and delivers clean dry air to the tools, thus reducing wear and prolonging their life. All internal parts are made of bronze or copper—resistant to corrosion and practically permanent. Copy of Bulletin DA fully describing the operation of DriAir sent on request; write today.

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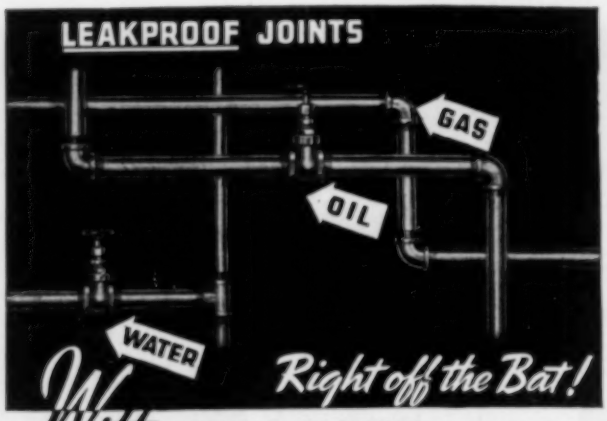

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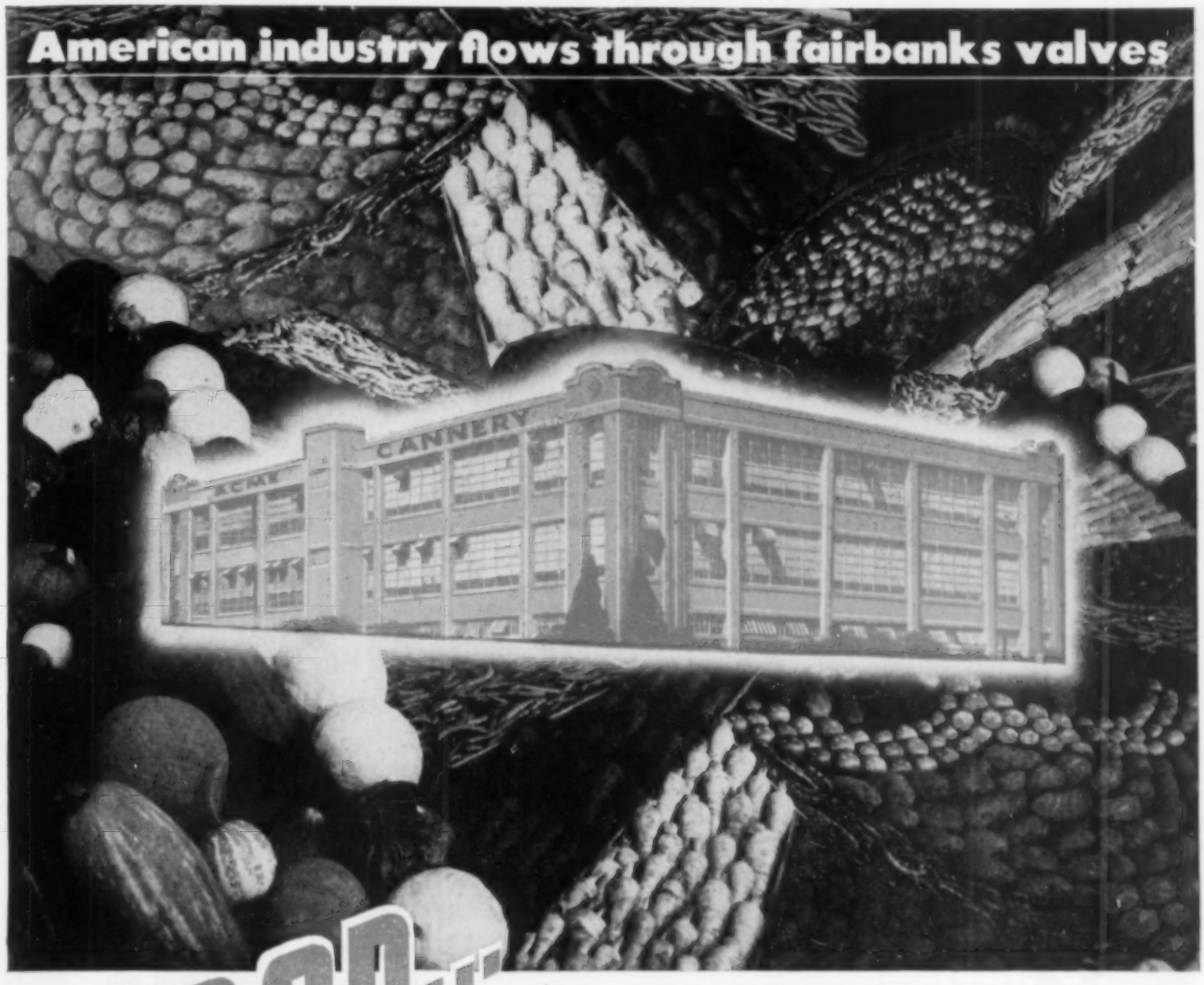
American industry flows through fairbanks valves



FOOD... foundation of peace

Before the rebuilding of devastated cities must come the rebuilding of the people. Many branches of the American food industry share in this job — dehydrators . . . canners . . . enrichers and fortifiers of foodstuffs . . . many kinds of processors.

Supplying valves to food processors is an old story to the makers of Fairbanks Valves. Not only are process liquids controlled dependably by Fairbanks valves but the steam lines in these factories' power plants are served by others of different types — as are plumbing and heating lines also.

The food industries typify many industrial fields where Fairbanks bronze and iron body valves give users the benefit of half a century of valve engineering. To see how completely one valve line can satisfy many needs, write for Catalog No. 42.

THE fairbanks COMPANY

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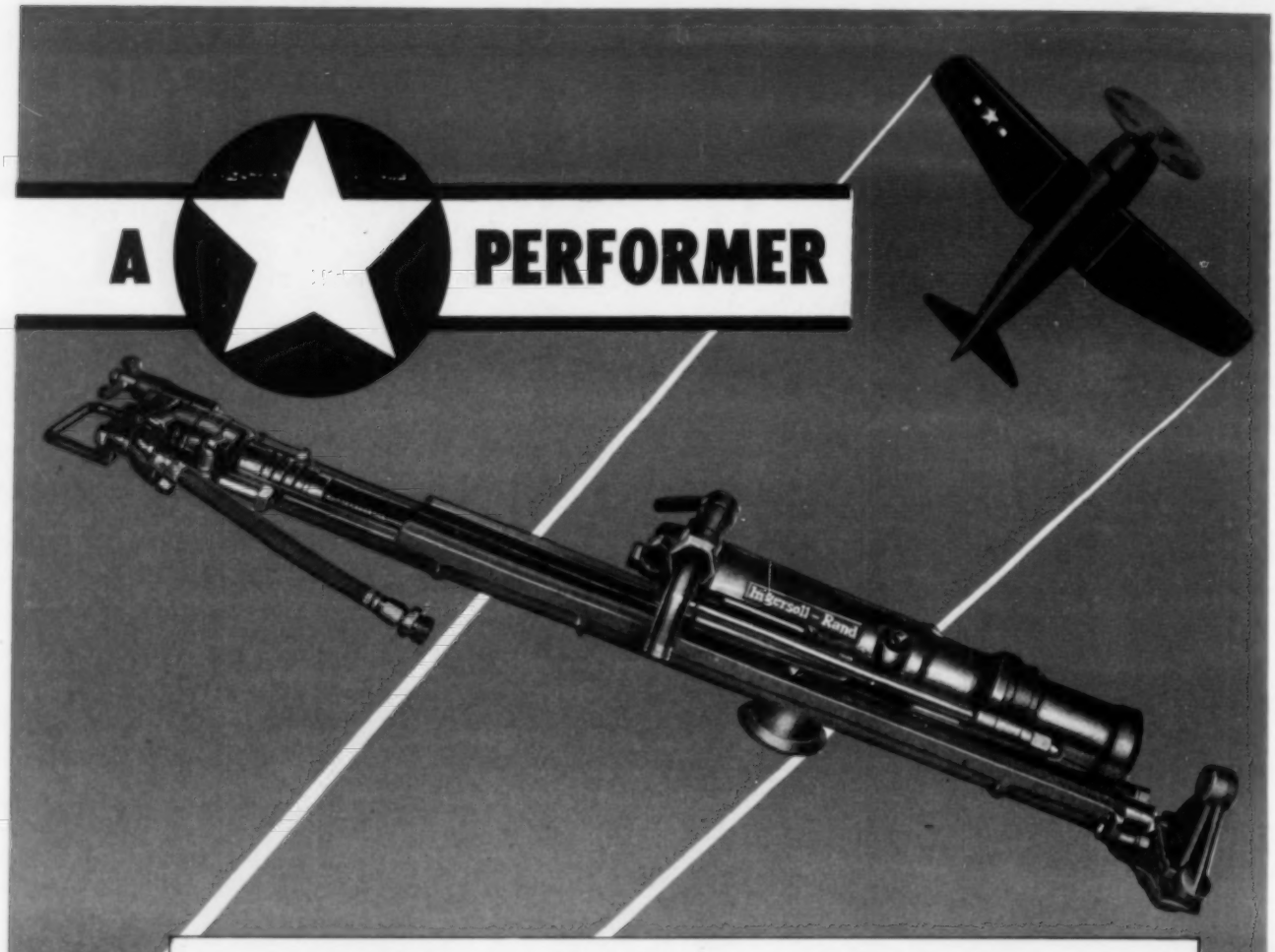

★ The DA-35 Drifter is the star performer in the medium-weight class. Its drilling speed is comparable to that of many heavier 4"-bore machines. This high speed will enable you to drill more footage per shift and mine more ore. Here are some typical reports from mining men:

"The DA-35 Power-Feed Drifter outdrills our other machines by three holes nearly every shift."

"The DA-35 outdrills our other machines as much as four inches in a 24-inch run."

★ Further proof of drilling speed is found in the following data, which show the advance made in one month on different tunnel jobs by jumbo-mounted DA-35 Power-Feed Drifters working three shifts per day. In each case, the figures listed are for a single heading.

	Tunnel Bore	Number of DA-35 Drifters	Tunnel Advance (in one Month)
Tunnel A	11'9" x 11'9"	4	1567 ft
Tunnel B	12' 9" x 12' 9"	6	1624 ft
Tunnel C	11' x 10'	5	1879 ft

★ DA-35 Drifters stay on the job, too. Five of these machines equipped with Power-Feed drove a total of 26,400 feet of tunnel in 513 days — an average daily progress of 51.46 feet.

Performance such as this requires unusual durability, as well as unusual speed. Yes, DA-35 Drifters are truly star performers.

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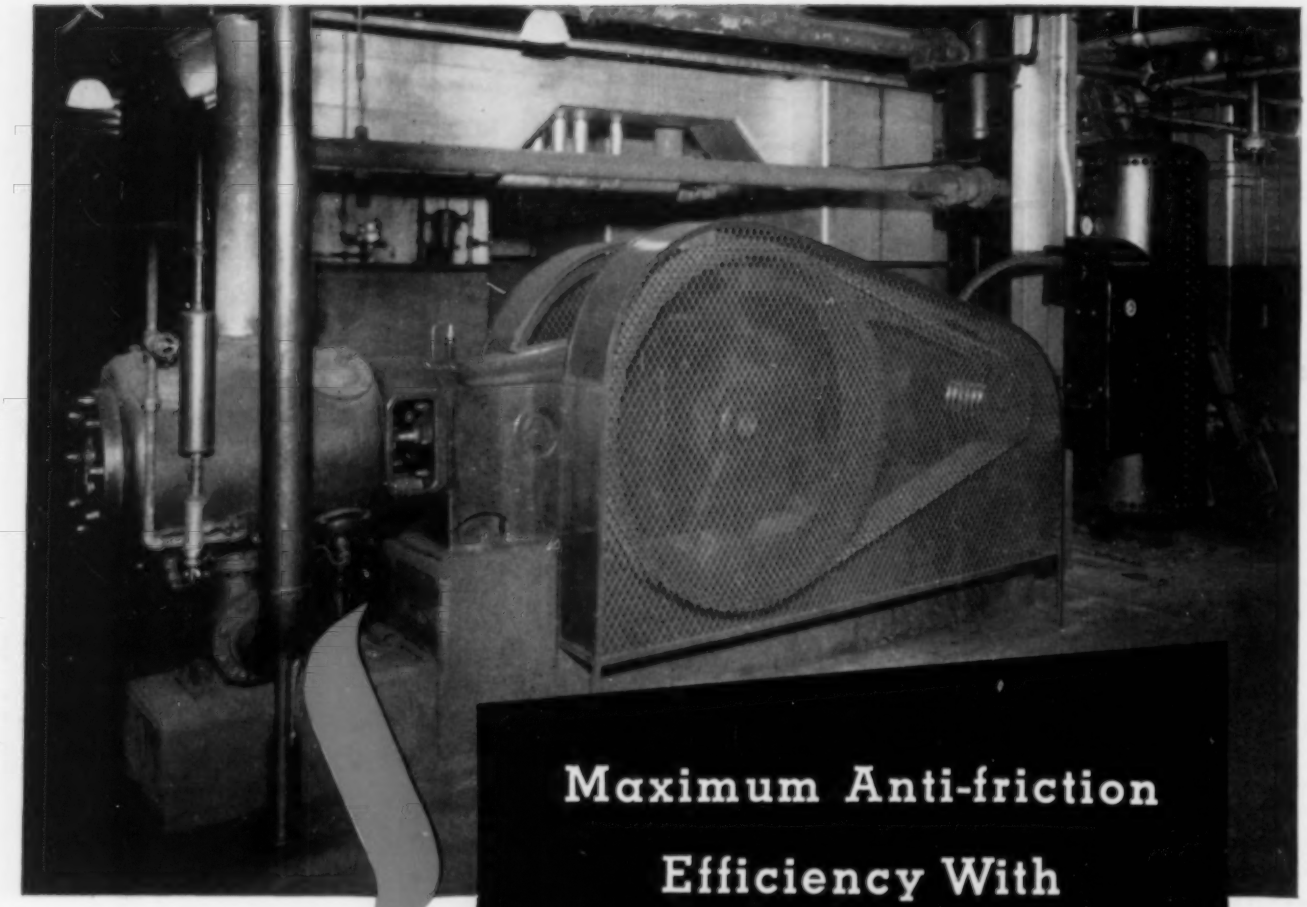

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Ingersoll-Rand Type ES Compressor equipped with Timken Bearings installed in power house of large eastern utility to furnish power for control instruments.

This Ingersoll-Rand 12 x 11 Type ES Compressor—like other types of Ingersoll-Rand anti-frictionized compressors—is equipped with Timken Tapered Roller Bearings.

Timken Bearings have proved to the complete satisfaction of users of Ingersoll-Rand Compressors, that they can be depended upon to provide anti-friction performance at its best, plus rugged endurance under all conditions of compressor operation.

Timken Roller Bearings not only eliminate friction; they also carry radial, thrust and combined loads; and hold moving parts permanently in alignment. It pays to have them in compressors and all kinds of machinery. Make sure you have them in your equipment — and see that the trade-mark "TIMKEN" is stamped on every bearing. The Timken Roller Bearing Company, Canton 6, Ohio.